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EXPERIMENTS ON THE FERMENTATION AND MOULDING OF CACAO.

by

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The following is a report of certain experiments on the fermentation of cacao carried out during the cocoa seasons 1928-29 and 1929-30.

THE NATURE AND OBJECTS OF FERMENTATION.

Knapp (1) states " Although cacao is fermented in nearly all the countries in which it is produced, the exact object and original intention of this process remains obscure. While good methods of cacao fermentation have been practised for many years, the literature on the subject—already voluminous—contains no full explanation which is generally accepted. The practice of fermentation is comparatively simple, but the actions and reactions which occur are complex and difficult to describe in non-technical language ".

The theory held is that fermentation of cacao is a biological process and is due to the action of yeast organisms in breaking down the sugars in the mucilaginous pulp surrounding the beans, with the production of alcohol and carbon dioxide. Later the action is bacterial, and the alcohol by an oxidation process is changed to acetic acid. To ensure a uniform inoculation with the fermenting organisms throughout the bulk of the cacao beans, the latter are changed or turned several times during the fermentation process, and in plantation practice it is usual to change the beans from one box to another once daily. During the biological process heat is generated, and when a temperature between 40° and 50°C is reached the cells of the beans are killed, with the liberation of their oxidising enzymes. The oxidising of the tannins present then causes the change of colour of the cotyledons from purple to brown. At this stage the vinous liquor of the pulp penetrates the husk, forces the cotyledons apart, and widens the convolutions of the latter. This makes the beans swell and imparts to the finally cured product a good " break ". The presence of air is necessary throughout the biological and enzymic processes, and the latter action continues throughout the subsequent drying operation. The astringent principle within the beans is reduced by fermentation and to a greater extent by subsequent roasting, and this latter operation also develops the aromatic principle within the beans.

The development of aroma is due to very minute quantities (0.006%) of the essential oil, linalool. Hart (2) in his book on cacao, sums up the objects of fermentation in the following words:—"The aim of cacao curing appears, therefore, to be threefold; to change the nature of the pulp, thereby ensuring the 'keeping' of the cacao; secondly, to develop flavour; and last, to change the character of the interior of the bean to a state which will facilitate the operations of the manufacture by giving it what is known as 'a good break'."

The above, in brief, is an outline of what takes place during fermentation and of the objects of carrying out this process. In practice, as is shown by the results obtained in our departmental cacao fermentation scheme, we find that it is almost impossible to foretell just how perfectly any bulk sample of cacao will ferment, and it is unusual to obtain a sample which is uniformly fermented throughout. One could easily explain these differences in the degree of fermentation if there were in Nigeria different type varieties of cacao, for although a certain change and improvement is brought about by fermentation, Hart (2) points out that "change depends far more upon the original or special qualities contained in the bean than upon any chemical change produced or caused by fermentation as induced by the planter". As the type variety of cacao grown in Nigeria is practically entirely foresteiro, the differences in the degree of fermentation obtained are due not to inherent characters of the beans but to other factors. In the fermentation of cacao we find arrayed against us many factors which at the present time are quite beyond our control.

We have no control of the organisms which bring about the fermentation. Knapp, in another work (3), states:—"Any organism which happens to be on the pod, in the air, or in the inside of the fermentary will multiply in the pulp, if the pulp contains suitable nourishment. Each kind of organism produces its own characteristic changes. It would seem a miracle if the same substance were always produced. Yet, just as grape-juice, left exposed to every micro-organism of the air, generally changes in the direction of wine more or less good, so the pulp of cacao tends, broadly speaking, to ferment in one way. It would, however, be a serious error to assume that exactly the same kind of fermentation takes place in any two fermentaries in the world, and the maximum variation must be considerable".

In addition to this absence of control of the all important biological factors there are many other conditions whose effect we cannot estimate at the present time. Thus, climatic conditions presumably operate, the degree of maturity of the beans most certainly affects the degree of fermentation, the amount of disease

within the beans is effective; the manipulation of the beans throughout the process is of importance, whilst the prevalence or otherwise of the cacao fly, *Drosophila sp.*, which aids in the inoculation of the mass of fresh beans with the all important yeast cells, is of great importance in determining the vigour of the fermentation.

AIM OF THE EXPERIMENTS.

In the following experiments the aim has been to alter the methods of fermentation in a variety of ways and observe the characteristics of the cured product. In addition to aiming at uniformly good fermentation, changes in process have been attempted with a view to reducing to a minimum the amount of mould on the cured beans. These moulds are, principally, species of *Aspergillus*, and as these are aerobic saprophytes it was considered that if the fermentation was carried out so as to exclude air to a certain extent, there might be a possibility of obtaining beans entirely free from mould. It has been pointed out above that in plantation practice the beans are changed from box to box at least once a day during fermentation. In native practice, however, this is rarely done, and the beans are changed very infrequently, and sometimes not at all. Whilst constant daily changes which result in the uniform distribution of the yeasts throughout the mass would seem, *a priori*, to be the ideal method, we have tried various ways of reducing the number of changing operations, in an attempt to obtain a fermented bean with a minimum of effort. Such a method, if successful, would appeal to the native cultivator more than the laborious one which daily changing involves. We have also endeavoured to change the process so as to aerate the mass of beans at different times throughout the fermentation period. In some cases we have aerated early in the process then prolonged the period of time between changes, and in others we have left the mass unchanged during the early part of the process and then aerated by daily changes. In all the experiments the temperature within the mass of beans was taken every day (except during the initial twenty-four hours, when there is no appreciable rise of temperature).

During certain of the fermentations, samples of the beans were taken and placed in sterile petri dishes. Loop-fulls of the adhering pulp were then placed on culture medium and the resulting organisms examined. All such cultures were found to be very mixed, with a preponderance of yeasts during the early stages and of bacteria during the latter stages of the process. The details of the fermentation experiments are summarised in Tables I and II.

TABLE No. 1.
FERMENTATION EXPERIMENTS, 1928-1929.

Sample No.	Treatment.	Date.	Average % Purple Beans.	Maximum temperature during fermentation.	REMARKS.
1.	Ordinary : changed every day	27/11/28 to 3/12/28	27	40.5°C at 4th day	6 days fermentation—this period could have been prolonged with good results as beans of purplish colour were plentiful.
2.	Under partially anaerobic condition.* Turned in box every 2 days.	27/11/28 to 5/12/28	39	42.5°C at 6th day	8 days fermentation—the fermentation was unequal and the beans at side of box were dark. The sample had many purple beans with hard break.
3.	Beans changed every 2 days otherwise treated normally.	27/11/28 to 5/12/28	24	44.5°C at 6th day	8 days fermentation—required a longer period. Sample had many purple hard beans.
4.	Turned every 2 days for 4 days then every day.	11/12/28 to 18/12/28	27	48.0°C at 7th day	7 days fermentation. Sample had fair percentage of purple beans but break was better than in No. 3.
5.	Under partially anaerobic condition : turned every 2 days but at end of 4 days banana leaves removed from side and at end of 6 days from bottom.	11/12/28 to 19/12/28	20	50.0°C at 8th day	8 days fermentation. Sample had good colour and break but too many adjustments necessary during fermentation.
6.	Changed every day.	11/12/28 to 17/12/28	36	48.0°C at 6th day	6 days fermentation—low percentage with good break. Fermentation would have been improved if continued for longer time.
7.	Germinated (treated with lot 6).	11/12/28 to 17/12/28	Nil		6 days fermentation. All sample well fermented of good colour and break.
8.	Changed twice daily: morning and evening.	3/1/29 to 10/1/29	Nil	46.0°C at 6th day	6 days fermentation. Sample of good colour and break.
9.	Changed every day for 3 days then every 2 days.	3/1/29 to 10/1/29	Nil	51.0°C at 6th day	7 days fermentation. Sample of good colour and break.
10.	Changed at end of 2 days then at end of 4 days then every day.	6/1/29 to 17/1/29	Nil	46.0°C at 3rd day	8 days fermentation. Sample of good colour and break.

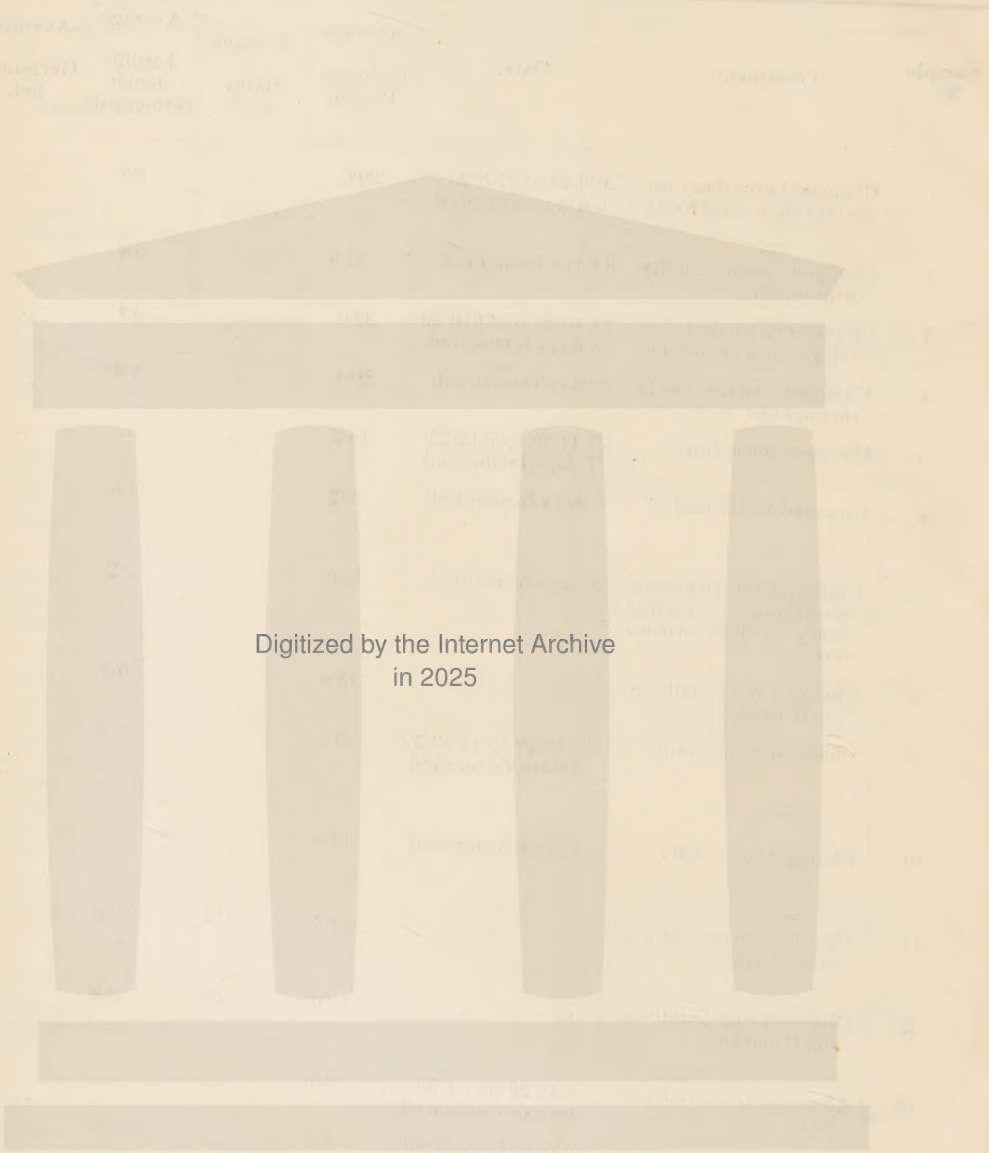
* The fermenting box in this experiment had thick layers of banana leaves at the sides, bottom and top.

TABLE II.
FERMENTATION EXPERIMENT 1929-30.

Sample No.	Treatment.	Date.	Average % Ordinary Purple.	Average % Slatey.	Average % Insufficiently fermented.	Average % Germinated.	Average % Mouldy.	REMARKS.
1	Changed twice daily for 2 days then on 5th day	20/8/29 to 27/8/29 6 days fermented	20.6	...	1.6	...	...	Light coloured beans. This sample developed disagreeable odour during fermentation and there is some evidence that it had not the same keeping qualities as No. 2. Cotyledons light chocolate and many close.
2	Changed twice daily throughout	6 days fermented	31.6	...	0.8	...	...	Beans fairly dark. Cotyledons chocolate: many close.
3	Changed twice daily for 3 days then on 6th day	22/10/29 to 30/10/29 8 days fermented	32.0	...	3.4	...	...	Light and dark beans. Cotyledons open, chocolate: a few close and purple. Sample was of better colour than No. 1.
4	Changed twice daily throughout	8 days fermented	30.4	...	1.2	...	...	Beans fairly light in color. Cotyledons of purplish colour: many close ones.
5	Changed once daily	27/11/29 to 7/12/29 7 days fermented	15.2	...	...	...	...	Beans dark externally. Cotyledons dark chocolate and open.
6	Changed twice daily	6 days fermented	32.2	...	1.6	...	...	Beans fairly light coloured. Cotyledons very open and very dark purple—darker than No. 7. From temperature records this fermentation was apparently not complete.
7	Under partial anaerobic conditions, turned every 2 days within box	9 days fermented	16.0	...	2.2	...	...	Beans light brown generally but some darker ones. Cotyledons distinctly purple generally. Some close. Fermentation not satisfactory.
8	Changed once daily in small basket	6 " "	13.8	...	0.8	...	...	Beans very dark—mostly black and brittle. Cotyledons very open and of good chocolate colour.
9	Changed twice daily	12/12/29 to 19/12/29 6 days fermented	28.8	...	7.4	...	...	Beans dark brown with some adherent pulp. Cotyledons distinctly purplish and generally open.
10	Changed once daily	7 days fermented	12.8	...	...	...	...	Beans dark brown with some adhering pulp. Cotyledons open and chocolate colour.
11	Changed twice daily in small basket	6 " "	14.4	0.2	3.0	...	...	Beans dark brown. Cotyledons very open, slightly purplish.
12	Changed once daily in small basket	7 " "	12.0	2.8	0.8	...	...	Beans light brown. Cotyledons very open and chocolate colour.
13	Changed once daily in box	31/12/29 to 7/1/30 6 days fermented	0.5	...	...	8	...	Beans light brown. Cotyledons very open, chocolate.
14	Changed twice daily in box	6 days fermented	4.2	...	...	8	...	Beans very light brown. Cotyledons very open—a few purple.
15	Changed once daily in large basket	6 " "	3.0	...	...	15	...	Beans were mixed dark and light brown. Cotyledons very open—a few purple.
16	Changed twice daily in large basket	6 " "	6.8	...	...	10	...	Beans light brown. Cotyledons very open, chocolate colour.
17	Very ripe beans in small basket changed once daily	6 " "	1.2	...	...	3	...	Beans light brown. Cotyledons very open, dark chocolate colour.
18	Ordinary ripe beans in small basket changed once daily	6 " "	7.0	...	...	6	...	Beans light brown. Cotyledons open and slightly purplish when compared with No. 17.
19	6 days fermented	31/1/30 to 6/2/30 6 days fermented	4.0	...	2.2	...	...	All these samples are from the same bulk of Cacao which was changed once daily. One-sixth was taken out and dried after 6 days fermentation and a similar amount for each succeeding day. The samples show a series of gradually darkening beans according to the fermentation period. Samples 22, 23 and 24 were quite black and of very inferior appearance. As the fermentation was prolonged moulds made their appearance externally and on examining immediately after drying it was seen that there was a gradual increase in the amount of internal moulds present. This prolonged fermentation produced a sample quite free of purple beans but was otherwise very inferior.
20	7 days fermented	7 days fermented	3.0	...	0.2	...	...	
21	8 days fermented	8 " "	1.0	...	...	5	2.0	
22	9 days fermented	9 " "	0.6	...	...	...	5.0	
23	10 days fermented	10 " "	...	...	...	...	12.8	
24	11 days fermented	11 " "	...	...	...	...	23.2	

All fermentations carried out in boxes unless otherwise stated.

TABLE II.
FERTILIZATION EXPERIMENT



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FACTORS WHICH INFLUENCE THE PROPORTION OF PURPLE BEANS.

From a consideration of the details given in Tables I and II it will be noted that the cured cacao obtained in the first half of the season had a high percentage of purple beans whereas in the latter part of the season this type of bean was almost absent. On examining cut beans in all the samples at the commencement of the main season crop one finds all gradations from quite fully fermented beans with a dark chocolate colour to those with different degrees of purple. Unless this is due to the Forestero cacao being of mixed botanical character it can only mean that the beans have reached various degrees of maturity at the time of harvesting. Since some beans emerge fully fermented from all the fermentations, it is suggested that the presence of a high percentage of purple beans in any sample is the result of the inclusion of a large number of immature pods in the early harvestings. Once the peak of fruit production has been passed, pickings are far less frequent, consequently a far higher percentage of fully mature fruits is harvested.

When fully mature beans are fermented they give a product which is chocolate in colour and has a good "break". This is shown in Sample 7, Table I, when only germinated beans were fermented and the cured product was 100 *per cent.* chocolate. It is also shown in Sample 17, Table II, where only selected mature beans were used. The correlation between maturity of bean and amount of purple beans is strikingly shown when we consider Samples 9 to 17 Table II. All appeared ready for harvesting at the same time, but as the amount of cacao was more than could be cured with the facilities available, the cacao used in Samples 13 to 17 was not harvested until almost three weeks after that used in Samples 9 to 12. The cacao was then found to be very mature and to contain germinated beans; the cured product contained a much smaller number of purple beans, and as the treatments in the two groups were practically identical the degree of maturity of the beans in these samples must have been the predominating factor which resulted in a much lower percentage of ordinary purple beans.

GERMINATED BEANS.

The germinated beans (Sample 7) were specially selected, wrapped in thin muslin and fermented normally with Sample 6. Although these beans showed 100 *per cent.* good fermentation, that of the bulk in which they were placed was only sixty-four *per cent.* Another factor, besides the degree of maturity, promotes fermentation in germinated beans, namely the ready ingress for the pulp liquor provided by the hole made in the husk by the growing radicle.

A weighed sample of these germinated beans, together with one of ordinary fermented beans, was placed under damp conditions and in four days in one experiment and five days in another the germinated one started to mould. The normal beans were then free, but commenced moulding a day later. It was found on reweighing the samples that whereas the germinated beans had reabsorbed 18.1 *per cent.* of moisture the normal fermented beans had absorbed only 13.8 *per cent.* These results merely confirm our previous findings, for we know that the better the sample is fermented the more moisture it will take up under damp conditions. External moulding being a concomitant of the moisture present, the more readily will the sample mould.

In spite of these germinated beans having such excellent colour and break, Booth and Knapp (4) state that germinated beans "give on roasting an inferior product with a slightly herbal odour and an astringent taste. The presence of even a small percentage of germinated beans exercises a deteriorating effect on the quality of any goods in which such cacao is used, hence we regard the presence of germinated beans as objectionable".

In addition to this serious indictment of germinated beans, the presence of holes in the husk provides a ready means of access for fungi, and, if conditions are damp, internal moulds quickly develop. The perforated husks also form means of ingress for insects and for this reason germinated beans are usually much damaged by insect attack, particularly if they are stored for some time. In addition to these defects it should be mentioned that germinated beans are much lighter than ordinary normal beans.

For these reasons, and until more uniform conditions of curing are adopted by the majority of the native cultivators in this country it seems a wise policy to continue to regard this type of bean as defective.

MESSRS. CADBURYS' REPORT ON 1928-29 SAMPLES OF FERMENTED CACAO.

Samples of these fermentation tests have been forwarded to Messrs. Cadburys for examination, and we have received a report on the 1928-29 tests from Mr. Knapp who is in charge of their Research Laboratory. He states that the first six samples are all within the range of cacaos which are normally received from Africa. In order of preference he places them 4, 6, 5, 2, 3. The quantity of beans sent in the No. 1 sample was too small for the accurate placing of this sample. With regard to Samples Nos. 8, 9 and 10 he writes, "The last three samples are of special interest. They all have loose shells and open cotyledons of a definite brown colour. They contain no purple beans and the colour internally is very good, probably the best we have seen. Sample No. 8 is the best

and then follow Nos. 10 and 9 in order." From the fact that samples 9 and 10, which received much fewer changes than No. 8, approximated so closely to the last sample, it would appear that the excellent quality of all three samples is due not so much to the method of fermentation but to the fact that they consisted of mature beans. Further evidence that this is probably the correct interpretation is obtained when we compare Sample 8, Table I, with Samples 4 and 6, Table II. In these three samples we had nearly identical weights of cacao. All were changed twice daily. Sample 8 (Table I) was fermented for seven days and Samples 4 and 6 (Table II) for eight and six days respectively, yet whereas the former sample contained no purple beans, Sample 4 had 30.4 *per cent.* and Sample 6 32.2 *per cent.* Now Sample 8 was of known mature beans, whilst the other two samples were early season cacao. As the treatment during fermentation is identical we can only assume that some condition of the beans experimented upon was different, and it appears to the writer that this is the condition of maturity; the two Samples No. 4 and 6 not being as mature as Sample 8.

EFFECT OF PROLONGED FERMENTATION.

We have seen that mature beans, after curing, give rise to a product free from purple beans. During the fermentation process beans change in colour from various degrees of purple to brown or chocolate and it would appear that, if the fermentation process were prolonged, a product would be obtained which would be quite free from purple beans. Samples 19 to 24, Table II were taken to test this. All the samples were from the same bulk of cacao and lots, one sixth of the total, were taken out and dried after fermenting for six, seven, eight, nine, ten, and eleven days, respectively. The beans used were mature and thus there was only a low percentage of purple beans in the six days fermented sample. It will be noted that the percentage of purple beans becomes less with each succeeding extra day of fermentation until the ten and eleven days fermented samples are quite free. At the same time the husks of the beans were progressively darkened as the fermentation period increased, until the last three samples were quite black and of very inferior appearance. During the fermentation moulds made their appearance, and the fermenting mass developed a disagreeable odour. Immediately on drying the samples were examined internally, and were found to have a steadily increasing percentage of moulds according to the degree of fermentation which they had undergone. The cotyledons of the samples fermented for ten and eleven days were very dark brown in colour. We conclude therefore that cacao beans can be entirely changed from purple to brown by prolonged fermentation, but the effect of too prolonged fermentation is to produce beans with black brittle husks

which are often split by the pressure of the fermenting juices. They are internally moulded and are much lighter in weight. Using a gauge and taking fifty beans each of Samples 19 to 24 and weighing we obtained the following weights in grammes:—53.85, 52.45, 50.60, 50.48, 50.41 and 49.31. It should be pointed out, however, that the fermentation of Samples 19 to 24 was not entirely normal because white ants appeared at the bottom of the fermentation box and interfered with the process. That this was so was evident from the temperature records which are the lowest that the writer has ever noted, being only 31°C at the end of the experiment, *i.e.*, 2°C higher than the prevailing air temperature. There is, however, some evidence, to which reference will be made later, that good samples of cacao can be obtained after prolonged fermentation.

EFFECT OF PARTIAL ANÆROBIC FERMENTATION.

A few of the fermentations carried out during these two seasons were performed under partly air-tight conditions. The whole of the cacao was enclosed by thick layers of banana leaves within the box, and the beans were merely turned within the box every two days. These samples were found, during fermentation, to contain numerous fungus hyphæ, and it can safely be stated that these conditions, far from inhibiting the development of moulds, actually increased them. On cutting cured beans fermented in this way they were found to be distinctly purple in colour generally, and to have a fairly high percentage of hard and close beans. The samples were unequally fermented, and the better fermentation occurred in the beans at the sides of the box. These were also darker in colour than beans from the centre. There is also some evidence that they have inferior keeping qualities than have more normally fermented samples. Thus Samples Nos. 1 and 2, Table I, were kept in bags in the laboratory and examined after an interval of over six months. The normally fermented sample (No. 1) was quite free from moulds whereas the one fermented under partly anærobic conditions was very mouldy both externally and internally. In addition to this method not giving a satisfactory fermentation a further objection to it is that it requires two to three days longer than does the normal method; this is not likely to appeal to the native cultivator.

EFFECT OF CHANGING THE CACAO DURING FERMENTATION.

In Table II it will be noted that the effect of changing once daily and twice daily has been repeated at different times in the season and has also been carried out in boxes, and in small and large baskets. In every case the sample changed twice daily contained a higher percentage of purple beans and of insufficiently

fermented beans. It is obvious that the fermentation had not proceeded far enough in the case of these samples changed twice daily. One reason for this was that there were not sufficient fermenting boxes available, and changes had to be made from the box into small baskets and from these the beans were returned to the original box. This resulted in the changing operation being prolonged with a resultant considerable reduction of temperature. In some cases the temperature was reduced 15°C . Such a reduction of temperature would inhibit the fermentation process. Throughout the process the beans were of a uniformly good colour and the fermenting mass had a sweet vinous odour, thus indicating that the process was going forward in a normal manner. There seems little doubt that the operation could have been prolonged for several days (it was limited to six days because that period of fermentation had produced such a splendid sample in the previous season—Sample 8, Table I). In this connexion it may be pointed out that on one plantation in the Cameroons it is the practice, using boxes in which the depth of cacao is generally not more than $2\frac{1}{2}$ feet, to change the beans twice daily and to ferment for as long as fourteen days. Whilst this makes the fermenting process rather costly, it is believed to give a better product on account of the better mixing of the beans, and also because the temperature of the mass is better controlled by these frequent changes.

The writer is firmly convinced that frequent aeration of the fermenting beans will produce the best sample of cured cacao, but the changes should be carried out as quickly as possible to prevent any great reduction in temperature.

PRODUCE REGULATIONS AFFECTING CACAO.

In the details of cacao fermented during the season 1929-30 (Table II) this Department's present system of grading has been kept in view. In the present Produce Inspection Regulation cacao is graded as follows:—

Grade I.—Cocoa which is thoroughly dry and contains less than three *per cent.* by count of mouldy, weevily, defective, decayed, “flat” and/or germinated beans and less than five *per cent.* by count of unfermented and/or “insufficiently fermented” beans.

Grade II.—Cocoa which is thoroughly dry and contains less than eight *per cent.* by count of mouldy, weevily, defective, decayed, “flat” and/or germinated beans and less than ten *per cent.* by count of unfermented and/or “insufficiently fermented” beans.

Grade III.—Cocoa which is thoroughly dry and contains less than eight *per cent.* by count of mouldy, weevily, defective, decayed, “flat” and/or germinated beans and ten *per cent.* or more by count of unfermented and/or “insufficiently fermented” beans.

Grade IV.—Cocoa which is thoroughly dry and contains eight *per cent.* or more but less than twenty *per cent.* by count of mouldy, weevily, defective, decayed, “flat” and/or germinated beans.

Cocoa which contains twenty *per cent.* or more by count of mouldy, weevily, defective, decayed, “flat” and/or germinated beans shall not be passed for export.

In Table II by ordinary purple beans are meant those which have a good break but are distinctly purple in colour. Such beans are counted as sufficiently fermented. Insufficiently fermented beans are those which are purple in colour and have no break, and slatey beans are counted as insufficiently fermented whether they have a break or not. The percentages given are the mean of ten counts. It will be noted that the cacao from the first twelve fermentation tests in the 1929-30 season would, with a single exception, be classed as Grade I. Sample 9, having over five *per cent.* insufficiently fermented beans would be placed in Grade II. Considered commercially, good samples of cacao can be produced with almost any method of fermentation. Samples changed very little at the commencement of the fermentation and samples changed several times at the commencement and then only once towards the end of the process have both produced Grade I cocoa. Samples not even changed but only turned within the box at two days intervals have also produced a first grade cocoa. Even samples fermented in small baskets have had the same desirable qualities. The complete absence of slatey beans, except in two cases where a small percentage was present, is of importance and inclines one to the opinion that where any fermentation has been carried out there should be little or none of this undesirable type of bean present. If samples contain some well fermented beans and a high percentage of slatey the latter may be regarded as being admixed and as having been derived from cacaos which either come from different sources or have undergone different treatments. Even when the fermentation has been carried out in a simple manner by changing within small baskets there should not be a high percentage of slatey beans. Our results show that very simple unlaborious methods will give a product of first grade standard. Although the only two samples which showed slatey beans were those fermented in small baskets, No. 11 and No. 12, it will be noted that Sample No. 8, treated in exactly the same way, gave a product which was superior to most of the samples fermented

in boxes. The January fermented cacao, although containing no insufficiently fermented and even very few purple beans yet does not reach Grade I standard, and is indeed mostly Grade IV, because of the high percentage of germinated beans. The only samples showing any internal mould were those which were fermented for a long period, when the process was far from normal.

INSECT DAMAGE TO CACAO.

It might be mentioned that some of the samples examined later in the laboratory showed evidence of insect damage and such cacao was from trays which were placed on the ground during the drying operation. Insect-infested beans which were forwarded for the writer by the Senior Entomologist to the British Museum were found to be damaged by *Lasioderma serricorne* F., a cosmopolitan beetle commonly found in stored food products.

FACTORS INFLUENCING EXTERNAL COLOUR OF CACAO BEANS.

It will be noted from the remarks in Table II on the colour of the beans externally that they varied considerably from black through various shades of brown to very light brown. Generally speaking the dark samples are indicative of a good fermentation and the longer this process continues the darker the sample will become. On the other hand samples inadequately aerated are lighter in colour.

There is some evidence available that the external colour of dried beans is correlated with the degree of maturity of the fresh beans. In the 1928-29 season there were noted within the pods many beans which were white owing to the pulp cells not having undergone any breaking down. A sample of these was taken and wrapped in thin muslin, and another sample of beans, in which the pulp cells had broken down so that the pink colour of the fresh husk was clearly apparent, was also placed in muslin and the two were fermented normally within a bulk sample of beans. After drying, the white beans gave a product of a light brown colour externally whereas in the other sample the dried beans were quite black. It is probable that here we were merely dealing with different degrees of fermentation and that the white beans were immature and did not ferment to the same degree as did the normal ones. The husks of the latter were more brittle than the former, which is evidence supporting this contention.

In addition, there are considerable differences in colour produced according to the climatic conditions which prevail at the commencement of drying. Thus samples dried rapidly under sunny conditions are lighter in colour than are those drying slowly under dull overcast conditions. Whether the first day's drying has been carried out under sunny or dull conditions is reflected by

considerable differences in the external colour; moreover the latter conditions usually produce a grey bean due to the presence of external mould. It will thus be seen that the external appearance of beans under Nigerian conditions of drying is in many respects largely a matter of chance, and often has little relation to the internal condition of the beans. From the texture of the husks we get a better knowledge of the method of treatment. Thus beans with brittle loose shells are well fermented. If the shells show small slit-like cracks it is indicative of over fermentation. Beans whose shells are hard are usually under fermented.

COLLAPSED OR WRINKLED BEANS.

It has been mentioned in a previous article that the initial drying during the first day is of great importance in keeping down external moulds but it ought to be mentioned here that very rapid initial drying of well-fermented beans results in their collapse; these wrinkled beans are indicative of well-dried well-fermented cacao.

TEMPERATURE DURING FERMENTATION.

Throughout all the fermentations the temperatures within the cacao were taken at least twice daily. These records show that the more frequent are the changes the more uniform is the temperature within the fermenting mass. This is to be seen from the following table, which also indicates that the temperature is highest in the better aerated beans, *i.e.*, those at the top of the heap, and that the larger the bulk of cacao fermented the higher will be the resulting temperature.

TABLE III.

TEMPERATURE DURING FERMENTATION PROCESS.

No. of days fermented.	Time of observation.	TEMPERATURE DURING FERMENTATION.				Air temper- ature in fer- menting house.
		Full Box.		Half Box.		
		Top.	Bottom.	Top.	Bottom.	
1.	12 noon	No	rise	in temperature		25°C
2.	8 a.m.	36.75°C	29.5°C	34.0°C	31.0°C	25.0°C
	5 p.m.	34.0°C	35.5°C	33.0°C	38.0°C	25.0°C
3.	7.30 a.m.	44.5°C	37.0°C	38.0°C	35.0°C	27.0°C
		Chang ed		Chang ed		
	11 a.m.	36.0°C	44.0°C	41.0°C	41.5°C	28.5°C
	5 p.m.	48.0°C	44.0°C	44.0°C	41.5°C	27.0°C
4.	8 a.m.	46.0°C	47.0°C	43.5°C	43.0°C	25.0°C

During a normal fermentation, when the cacao is changed once or twice daily, the maximum temperature (48° to 50°C) is reached about the fourth day and from this point we get a gradual fall. Partially excluding air during the process, by any means, *e.g.*, turning the beans within the box instead of changing from box to box, or reducing the number of changes, etc., results in a lowering of the temperature, but under these conditions and usually towards the end of the process it sometimes happens that temperatures higher than normal occur. These are due to thermophilic organisms which produce an undesirable fermentation which is usually indicated by a disagreeable odour.

In Table III the temperatures of the smaller bulk of cacao are slightly below those obtained in a full fermenting box. This is much more so in the case of small quantities of cacao fermented within small baskets, as will be seen in Table IV where temperature records are given of cacao fermentations within a box and within baskets. All samples were changed once daily immediately after the temperature was recorded in the morning, and this accounts for the lower afternoon temperatures.

TABLE IV.

TEMPERATURES DURING FERMENTATION PROCESS WITHIN BOX,
LARGE BASKET AND SMALL BASKET.

No. of days fermented.	Time of observation.	TEMPERATURES OF CACAO.			Temperature of air.
		Cacao in box. Weight=926 lb.	Cacao in large basket. Weight = 295. lb.	Cacao in small basket. Weight = 88 lb.	
2.	9 a.m.	28°C	28°C	26°C	17°C
	3 p.m.	29°C	27°C	25°C	26°C
3.	9 a.m.	40°C	35°C	30°C	23°C
	3 p.m.	37°C	34°C	29°C	31°C
4.	9 a.m.	50°C	50°C	35°C	19°C
	3 p.m.	46°C	42°C	33°C	31°C
5.	9 a.m.	49°C	46°C	44°C	25°C
	3 p.m.	48°C	47°C	47°C	32°C
6.	9 a.m.	50°C	50°C	44°C	26°C
	3 p.m.	47°C	49°C	46°C	29°C
7.	9 a.m.	52°C Removed	47°C to drying	40°C trays.	26°C

Considering the temperature relations we find :—

(a) That there is practically no rise in temperature during the first twenty-four hours.

(b) That the temperature increases first in the upper layer of the fermenting mass of beans. This indicates that the presence of air increases the biological activities of the organisms causing fermentation.

(c) That changing the cacao, whilst raising the temperature of the whole bulk, tends to make it more uniform. This is due to the operation increasing the aeration of bulk and facilitating the distribution of the fermenting organisms.

(d) That small bulks of cacao reach much lower temperatures; this is probably due to the increased surface, relative to bulk, exposed to evaporation, with consequent loss of heat.

(e) Temperatures higher than 50°C usually indicate undesirable fermentation : when this occurs the mass of beans often develops a disagreeable odour.

MOISTURE CONTENT OF EXPORTABLE DRY CACAO AND ITS CORRELATION WITH SUBSEQUENT MOULDING.

In a previous article (5) the writer has dealt with the hygroscopic character of cacao beans and indicated the relation between their water content and the relative humidity of the atmosphere. Further work, in considerable detail, has been carried out by Scott (6) and Dade (7) on the Gold Coast and the latter concludes that beans which have a moisture content of over eight *per cent.* are likely to develop mould. We have subjected dry cacao beans to a very high humidity (95 R.H. by using ten *per cent.* caustic potash) and have found that the beans were definitely moulded in three weeks time, the percentage moisture then being 10.9. This is the mean of five samples of cacao. On cutting such beans the perithecial stage of *Aspergillus glaucus* was found to be present so that the internal moulding had certainly commenced some time before the beans were examined, and our figure for the percentage moisture content when moulding occurs is too high. It is obvious, however, in an experiment such as this that, by subjecting beans to a very high atmospheric humidity and retaining them under such conditions for a period, we are creating artificial conditions which favour fungus development. Also, if we keep cacao beans

which have a high moisture content under conditions which prevent or inhibit drying, we are again facilitating the production of moulds. The need for a study of the relation between moisture content of beans and mould production under natural conditions is indicated. Cacao, whether stored in bulk or in bags, is affected by the daily fluctuations of atmospheric humidity and it was considered that, if beans were subjected to a high humidity for a few hours, followed by exposure to a lower one, then high, etc., they would not develop moulds to the same extent as would beans submitted to a constantly high humidity.

To test this two samples of cacao of known moisture content were taken. One sample was subjected to the atmospheric humidity of the laboratory only. It was suspended within a wire-mesh tray so that the beans were in free contact with the air. The other sample was kept alternately under moist and dry conditions by placing it, first, over water in a desiccator which was afterwards evacuated, then, after being weighed, in another desiccator over conc. sulphuric acid. The relative humidity of the air in the laboratory was taken at 9 a.m. and 3.30 p.m. daily by means of a wet and dry bulb thermometer and the samples of cacao weighed at the same time. The sample in air varied in a normal manner and in accordance with the variations in atmospheric humidity. Usually weight was gained at night when the R.H. was high, and lost during the day when the humidity dropped. The percentage moisture of the sample was 6.9 at the commencement of the observations and gained slightly during the month of October, reaching eight *per cent.*, its maximum, in a month. During the dry period in November the beans lost moisture and after two months at the end of the observations the sample only contained 6.0 *per cent.* moisture. During the period when these observations were made the R.H. at 9 a.m. showed a mean of eighty-seven *per cent.* whilst in the afternoon the mean was seventy-seven *per cent.* This sample, at the end of two months observations, was entirely free from moulds. This result confirms Dade's conclusion that cacao having a moisture content not in excess of eight *per cent.* will not mould. The experiment also indicates that a well-fermented sample, if well dried, can be stored in a dry place for a long time and still remain free from mould. The other sample, which was placed alternately under extremes of moist and dry conditions, was kept moist from 9 a.m. to 3.30 p.m., *i.e.*, six and a half hours, and dry for the remainder of the time, *i.e.*, about seventeen hours. These conditions obtained for the first three weeks of the experiment. During this period the mean percentage moisture of the sample whilst under dry conditions was 4.4 and under damp conditions 8.3. As, during the first three

weeks of the experiment, there were no signs of external moulds, the sample was then placed alternately under dry and moist conditions for periods of about twenty-four hours in each case. It was then found that under the dry conditions the mean percentage moisture was 4.2, whereas under the damp conditions the moisture content was 12.4 *per cent.* When the observations had been carried on for two months this sample showed external moulds and on cutting the beans fifty-four *per cent.* were found to be infected internally. The fungus present was *Aspergillus glaucus*, which is the principal mould found on commercially dry cacao beans. This fungus is able to survive fairly dry conditions, a fact which is very evident when one states that the moisture content of the beans fell below two *per cent.* on several occasions. The experiments show that fluctuations in moisture content which do not give a maximum content of over eight *per cent.* do not facilitate mould production but fluctuations giving a much higher moisture content are instrumental in promoting such growths. It will, therefore, be obvious how necessary it is to avoid the rewetting of cured cacao, for, even if such is thoroughly dried before shipment, mould growth may have been initiated and may continue its development during subsequent transport and storage. Such cacao may be badly internally moulded by the time it reaches the cocoa manufacturers.

Throughout the last cacao season we have obtained samples of cacao through the Produce Inspector from most of the commercial stores in Ibadan and we have estimated the percentage moisture content, percentage mould and insect damage and in some cases the amount of purple and slatey beans. The results are shown in Table V. It was thought that possibly there would be some correlation between the percentage moisture present and the climatic conditions prevailing at the time the cacao was dried. Such a correlation is not evident from Table V, but the results given show that the rough and ready methods employed by the Produce Inspectorate are such that only quite dry samples with a safe moisture content are generally passed. Of seventy samples taken very few are in the danger zone and only four have more than nine *per cent.* of moisture.

TABLE V.

MOISTURE CONTENT AND DEFECTS OF COMMERCIAL COCOA
THROUGHOUT THE SEASON 1929-30.

Date taken.	Sample No.	Weight 50 beans in grms.	% Moisture.	% Mould.	% Weevilly.	REMARKS.
July 22nd ...	1	46.30	7.8	10	...	End of season crop.
" 24th ...	2	47.50	8.1			
" 24th ...	1	50.55	8.1	...	...	Beginning of season crop.
" 26th ...	2	50.80	8.1			
" 26th ...	1	46.47	8.8	...	...	
" 29th ...	2	46.45	9.1			
" 29th ...	1	49.85	8.1	...	...	
" 29th ...	2	50.33	8.0			
August 3rd ...	1	46.72	8.4	3	3	Had 48% purple and slatey beans.
" 17th ...	2	46.72	8.6			
" 17th ...	1	51.43	8.6	6	...	
" 24th ...	2	51.28	8.9			
" 24th ...	1	51.33	9.9	2.5	...	
" 31st ...	2	51.33	10.3			
" 31st ...	1	55.22	7.2	3	...	About 10-15% slatey and purple beans.
" 31st ...	2	55.22	7.3			
Sept. 7th ...	1	57.80	8.2	8	1	
" 14th ...	2	57.95	8.4			
" 14th ...	1	56.80	7.9	...	...	
" 21st ...	2	56.83	8.0			
" 21st ...	1	56.28	8.8	2	1	Mixed sample—large number of slatey beans.
" 28th ...	2	56.40	9.2			
" 28th ...	1	57.08	8.0	2	...	Large % of purple beans.
" 28th ...	2	57.12	7.7			
Oct. 5th ...	1	61.90	7.7	1	...	24% slatey, 19% purple beans.
" 12th ...	2	61.62	7.4			
" 12th ...	1	56.54	7.1	1	...	16% purple and 20% slatey beans.
" 19th ...	2	56.54	7.4			
" 19th ...	1	54.09	6.1	4	...	20% purple and 23% slatey beans.
" 26th ...	2	54.09	6.4			
" 26th ...	1	51.58	8.6	4	...	34% purple and 10% slatey beans.
" 26th ...	2	51.59	8.4			
Nov. 2nd ...	1	50.28	7.3	1	...	26% purple and 4% slatey beans.
" 9th ...	2	50.29	7.2			
" 9th ...	1	56.18	7.2	2	...	22% purple and 6% slatey beans.
" 16th ...	2	56.19	7.4			
" 16th ...	1	61.37	8.1	5	...	31% purple and 12% slatey beans.
" 23rd ...	2	61.15	7.9			
" 23rd ...	1	56.16	7.5	...	...	31% purple and 18% slatey beans.
" 30th ...	2	56.18	7.6			
" 30th ...	1	57.93	6.9	...	...	31% purple and 2% slatey beans.
" 30th ...	2	57.93	7.2			
Dec. 7th ...	1	56.05	7.5	2	...	21% purple and 7% slatey beans.
" 14th ...	2	56.10	7.5			
" 14th ...	1	58.65	6.8	1	...	26% purple, 14% slatey beans.
" 21st ...	2	58.66	7.0			
" 21st ...	1	56.32	6.8	1	...	8% purple and 22% slatey beans.
" 28th ...	2	56.35	6.7			
" 28th ...	1	59.54	6.0	5	...	23% purple and 3% slatey beans.
" 28th ...	2	59.54	5.7			
1930:—						
Jan. 4th ...	1	58.22	7.8	3	...	24% purple and 2% slatey beans.
" 4th ...	2	58.23	8.0			

TABLE V—*continued*.

MOISTURE CONTENT AND DEFECTS OF COMMERCIAL COCOA
THROUGHOUT THE SEASON 1929-30.

Date taken.	Sample No.	Weight 50 beans in grms.	% Moisture.	% Mould.	% Weevilly.	REMARKS.
Jan. 11th ...	1	58.47	6.7	4	...	22% purple and 10 slatey beans.
	2	58.50	6.9			
18th ...	1	57.97	6.8	...	...	21% purple and 4% white spot beans.
	2	57.99	6.6			
" 25th ...	1	60.25	8.3	4	...	2% slatey and 4% insufficiently fermented beans.
	2	60.12	8.5			
Feb. 1st ...	1	57.70	6.9	...	...	5% insufficiently fermented
	2	57.65	7.2			
" 8th ...	1	56.89	7.5	...	...	34% purple beans.
	2	56.90	7.9			
" 15th ...	1	60.15	7.3	2	...	13% purple and 17% slatey beans.
	2	60.18	7.3			
" 22nd ...	1	56.15	7.2	...	...	24% purple, 24% slatey and 3% insufficiently fermented.
	2	56.16	7.1			
March 1st ...	1	58.25	7.6	...	...	18% slatey, 16% purple and 4% insufficiently fermented.
	2	58.23	7.2			
" 8th ...	1	66.91	7.5	...	...	20% slatey, 12% purple and 4% insufficiently fermented.
	2	66.93	7.7			
						23% slatey, 13% purple and 6% insufficiently fermented.

Only beans having a length of twenty-three mms. and thickness of seven mms. were taken.

Only beans having a length of 23 mms. and thickness of 7 mms. were taken.

The amount of mould recorded shows no relation to the percentage moisture present, but is dependent on the previous treatment during curing, the conditions of the cacao as regards maturity and amount of disease, and the length of time the cacao has been stored before passing the produce examiners. It will be noted that the samples contain a large percentage of purple and slatey beans.

FUNGI ISOLATED FROM CACAO BEANS.

In addition to *Aspergillus glaucus* already mentioned, the following species of *aspergillus* have been isolated and their identity determined by the Imperial Bureau of Mycology:—

A. flavus, Link., *A. fumigatus*, Fresen., *A. tamari*, Kita., and *A. sydowi*, Bain and Sartory.

WHITE SPOT DISEASE.

The cacao obtained during the latter part of the season in both the seasons which this investigation covers showed the white spot condition on the cotyledons of the dry beans. This only occurs during harmattan conditions and the white postules, consisting of cacao-fat and other deposits, are produced during the rapid evaporation which occurs whilst fermentation is taking place.

OTHER CONDITIONS PRODUCING MOULDING OF CACAO.

In addition to the factors intimately bound up with the moisture content of beans, which have already been dealt with in connection with the production of mouldiness in commercial cacao, some other causes may be conveniently summarised here. Unripe and diseased beans are one source, as these dry more slowly than do normally mature beans and thus induce the development of moulds. Beans which adhere together by reason of the placental tissue between them form foci for the development of moulds, and the necessity for separating such at the commencement of drying is indicated. (Quite apart from these "Cobs" facilitating mould production, their presence within a sample of cocoa involves extra operations on the part of the cocoa manufacturer). Moulds are likely to appear if the fermenting mass is not well covered. The temperature of the outer layer of such an uncovered bulk of fermenting cacao is actually one or two degrees less than the air temperature prevailing. This is because of loss of heat due to evaporation from wet beans. Ubiquitous fungi such as species of *Aspergillus* and *Mucor*, etc., find such cacao an excellent pabulum, and, as the temperature is about the optimum for their development, the sample will become quite mouldy in about twenty-four hours time. Some external moulding cannot possibly be avoided, under Nigerian conditions, as unsatisfactory climatic conditions may prevail at a time when the fermented beans are ready for drying.

INTERNAL MOULDING OF CACAO.

Whilst the presence of internal moulds within germinated beans is easily accounted for because fungi have a ready means of ingress through the holes in the husks which are produced by the developing root, other beans are often met with which, although apparently undamaged externally, are yet found to be internally mouldy. It appears, from observation of a large number of cases, that fungi enter the bean at the root or micropylar end, for the greatest development of mould is usually found in this position. Ten samples of cacao from the end of the 1928-29 crop were taken.

Each consisted of fifty beans externally mouldy. They were placed in a humidifier in May, 1929, and examined by cutting three months later. The mean percentage of beans which showed mould production predominantly around the radicle was eighty-three. Further experiments were then carried out with the object of getting more detailed knowledge on this point.

The beans used in the later experiments were freshly fermented and on cutting had no internal mould. They were partially or wholly covered with a toxic cement consisting of "Necol" (a celluloid varnish) to which finely powdered copper sulphate and mercuric chloride had been added. One lot of cacao (40 beans) had the micropylar end of the bean dipped into this poison, a similar number were coated at the opposite end of the bean, whilst ten beans were completely covered. All the beans were then well mixed with a sample of cacao which was very mouldy externally, placed within a humidifier and kept therein for a month. They were then cut and examined. Those with the micropylar end covered showed ten *per cent.* internally moulded, whilst where the micropylar end was open to infection seventy-six *per cent.* showed this type of mould. The sample of beans wholly covered with the toxic substance was found to be quite free from internal moulds.

Another experiment was carried out which gives further support to the conclusion that fungi enter the beans by way of the micropyle. Melted wax was poured into two petri dishes to a depth of half-an-inch and, before it had solidified, cacao beans were arranged so that their long axes stood perpendicularly out of the wax. As many as possible were used, and in one dish the micropylar end of the beans was embedded in the wax whilst in the other it was left exposed. They were then sprayed with a spore suspension of *Aspergillus flavus* and placed within a humidifier. As the fungus made very rapid growth the exposed beans were quickly covered with mould and after eight days they were cut and examined. In those beans where the micropylar end was infected with *A. flavus* eighty-eight *per cent.* were internally moulded, whereas, in the case of those beans whose micropylar end was not exposed to infection there were only thirty-nine *per cent.* internally moulded. Since carrying out these experiments the writer has noted that Dade (7), working on this same problem, also gives evidence that infection occurs usually at the micropylar end of the bean; he shows by photomicrographs the actual presence of the fungi within the tissue of the testa at the micropyle.

EXAMINATION OF THE INTERNAL STRUCTURE OF THE HUSKS OF FERMENTED AND UNFERMENTED BEANS.

With a view to finding some anatomical structural differences which might provide a reason for the greater absorption of moisture by the husks of fermented beans, pieces of husks of well-fermented and of unfermented beans were sectioned with a microtome and examined microscopically.

Immediately below the remains of the pulp cells of the husk there is a layer of sclerotial or hard stone cells. It was considered that possibly during fermentation this layer of cells, during the swelling of the bean, would become disorganised and thus allow for the ready access of moisture. It was found that this layer of cells was broken in both types of husk, but to a greater extent in the case of that of fermented cacao. The disorganisation of the cellular structure of both types of husks was, however, so pronounced as to afford no reliable evidence bearing on this problem. The writer is of the opinion that differences in the chemical nature of the husks might cause differences in the hygroscopic characters of the two kinds of beans, since the husks of fermented beans become impregnated with substances arising from the cacao "sweatings". In this connection Wadsworth (8) states that the percentage of theobromine present in the husks is an indication of the amount of fermentation to which the beans have been subjected. Thus he finds 1.63 *per cent.* in the husks of well-fermented Accra beans and only 0.17 *per cent.* in that of unfermented beans. This latter percentage is also the amount present in the husks of beans taken fresh from the pod. This theobromine is lost by the cotyledons (nib) during fermentation. Possibly other substances may be interchanged between nib and husk during fermentation and, by their presence, thus render the latter more hygroscopic and, as a consequence, more prone to moulding.

SUMMARY.

(1) The results of the experiments indicate that cacao cannot be prepared free from purple beans unless the beans are very mature, or unless the fermentation is unduly prolonged.

(2) As over-ripe beans are usually germinated, and over-fermented ones dark, very brittle, and may be internally moulded, it would appear that no method of reasonable fermentation will prevent the occurrence of some purple beans in ordinary cacao.

(3) Freedom from "insufficiently fermented" beans can be obtained by very unlaborious fermentation. Practically any of the methods employed has achieved this.

(4) In all the fermentations, with one exception, slatey beans were absent. The presence of this type of bean in a sample which contains well-fermented beans indicates that such a sample is of mixed origin.

(5) Perfectly good fermentation has been obtained in small quantities of cacao in baskets.

(6) Mixing the cacao in the box, though not giving quite as good a result as changing from box to box, has given a Grade I cacao.

(7) External appearance, whilst in part dependent upon the condition of the beans and the duration of the fermentation, is very much a matter of chance and dependent on the climatic conditions obtaining during the curing.

(8) Collapsed beans, often met with in samples of cacao, are due to very rapid drying of well-fermented cacao during the first day.

(9) Exportable dry cacao from the Ibadan district, when passed by the Produce Examiners, has generally a low moisture content which is such that the risk of subsequent moulding is almost negligible.

(10) Internal moulding only occurred in one series of samples which were over-fermented.

(11) Evidence is given that the fungi causing internal moulding enter the bean through the micropyle.

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THE EFFECT OF FREQUENCY OF CULTIVATION ON MOISTURE CONTENT AND NITRIFICATION IN SOIL AND ON CROP YIELDS.

A RECORD OF SOME EXPERIMENTS CARRIED OUT AT MOOR PLANTATION,
IBADAN, IN 1927 AND 1928

BY

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1.—PRELIMINARY WORK, 1927.

It is well known that proper surface cultivation of the soil by improving the conditions of moisture and aeration and consequently of nitrification may lead to a marked improvement in crop growth and yield.

Whilst carrying out regular determinations of the nitric nitrogen and moisture content of some experimental plots on Moor Plantation early in 1927, it was observed that in some circumstances reridging the soil seemed to have a very marked effect on the accumulation of nitric nitrogen. This effect was so pronounced that it was desirable to carry out an experiment to obtain further information on the matter, especially as at the time it seemed probable that a deficiency of nitrogen was a factor limiting crop growth. An experiment was started in October, 1927. This was admittedly late in the season, but it was hoped that the experiment would nevertheless yield definite qualitative information if not accurate quantitative data.

The details of the experiment were as follows :—About half-an-acre of land was selected which had been fairly uniformly cropped, and which had had a crop of mucuna growing on it since the previous April. This green manure crop was turned in and the land was divided up into six small equal strip plots of about one-tenth of an acre in area. A crop of late maize was sown on 19th October. Plots Nos. 1, 3, 5 were controls on which the weeds were cut by hand when necessary and Nos. 2, 4, 6 were given a light surface cultivation every week.

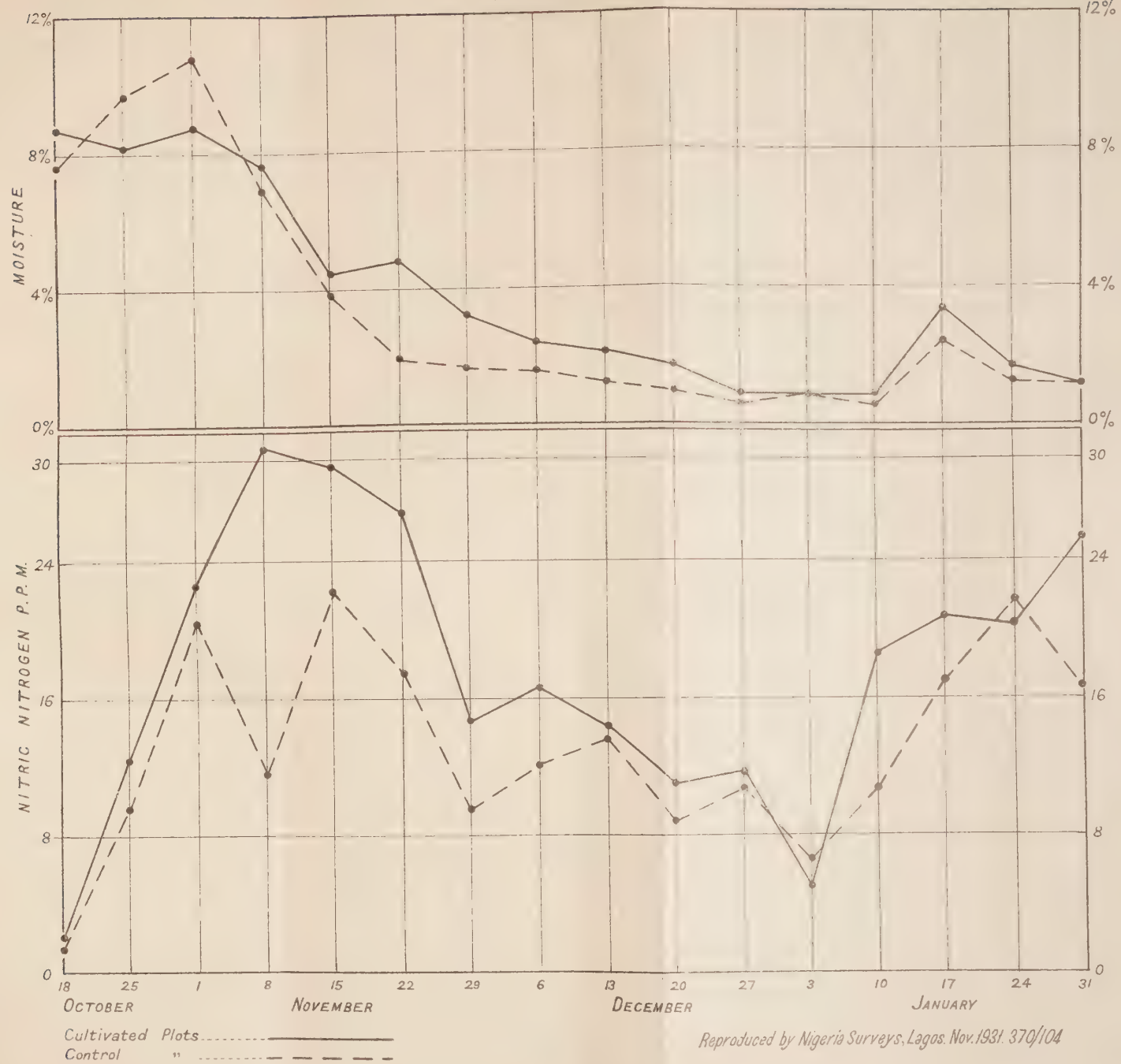
As the experiment had to be started so late in the season, the maize was sown nearly six weeks after the normal time. A further error was introduced by the carelessness of the boys who caused a certain amount of damage to the crop while carrying out the weekly cultivations. In spite of these defects the maize on the cultivated plots grew very much better than that on the uncultivated plots, so that it was possible to see from a distance the very marked difference between the two sets of plots.

TABLE No. I.
CULTIVATION EXPERIMENT, FIELD A3, OCTOBER, 1927.
WEEKLY DETERMINATIONS OF MOISTURE (%) AND NITRIC NITROGEN (ppm).

Date.	Plot 1.		Plot 2.		Plot 3.		Plot 4.		Plot 5.		Plot 6.	
	Moist.	Nit.	Moist.	Nit.	Moist.	Nit.	Moist.	Nit.	Moist.	Nit.	Moist.	Nit.
18th October ...	7.7	1.1	8.3	3.2	7.9	1.5	9.2	1.7	7.7	2.3	8.1	2.2
25th October ...	8.0	6.5	7.5	7.5	9.0	10.0	8.4	6.0	12.1	20.0	8.1	15.0
1st November	19.8	30.0	10.0	22.5	12.1	17.5	9.9	20.0	9.3	15.0	9.4	25.0
8th November	7.7	10.0	7.8	50.0	6.4	13.3	7.3	25.0	6.4	11.2	7.7	16.6
15th November	4.3	20.0	2.3	25.0	4.2	17.5	5.4	35.0	3.1	28.5	5.3	28.0
22nd November	2.1	11.2	5.9	23.2	1.7	15.0	4.9	27.5	1.9	25.0	3.6	30.0
29th November	1.5	20.0	3.2	11.6	1.3	11.2	3.1	17.5	1.2	7.5	2.9	14.2
6th December	1.3	7.5	2.1	15.0	1.3	13.5	2.3	17.5	2.0	15.0	2.3	17.5
13th December	0.9	14.2	1.5	11.5	1.1	15.0	2.5	17.5	1.1	11.5	2.0	13.3
20th December	0.67	6.3	1.9	8.4	0.9	13.9	1.5	12.5	0.8	7.5	1.3	12.5
27th December	0.8	10.0	1.2	8.3	0.9	11.7	0.9	12.5	0.7	11.3	0.9	15.0
3rd January ...	0.8	5.6	0.9	4.2	1.2	8.8	1.1	2.9	0.8	4.0	0.9	8.0
10th January ...	0.6	11.2	0.7	15.0	0.6	10.7	1.1	17.5	0.7	10.0	1.1	22.5
17th January ...	2.8	15.0	5.2	18.4	2.3	15.0	2.0	22.5	2.2	21.9	2.0	20.0
24th January ...	1.5	25.0	1.1	12.5	1.3	22.5	1.9	23.6	1.0	17.5	1.2	25.0
31st January ...	0.9	19.2	0.9	22.5	1.2	15.0	1.0	28.0	1.0	15.0	1.1	25.0

CULTIVATION EXPERIMENT FIELD A3 - 1927

FIG. I



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TABLE II.

CULTIVATION EXPERIMENT, FIELD A3, 1927.

Yields of Late Maize Crop.

Plot.			Grain lb. acre.	Straw lb. acre.
1.	Control	...	... nil	655
2.	Cultivated	...	... 188	973
3.	Control	...	... nil	573
4.	Cultivated	...	... 208	1,078
5.	Control	...	... nil	600
6.	Cultivated	...	... 219	1,240

Mean crop on cultivated plots—205 lb./acre.

The moisture content and nitric nitrogen determinations were made every week. The cultivated plots were hoed on Saturday mornings and the samples were taken on Tuesday mornings.

The results of these determinations are shown in Table 1. The weekly means for each treatment are shown graphically in figure 1. The yield results are given in Table 2.

There are certain minor inconsistencies in the results but on the whole it will be seen that there was a greater moisture content and a greater accumulation of nitric nitrogen on the cultivated plots than on the control ones. This is well brought out by the diagram.

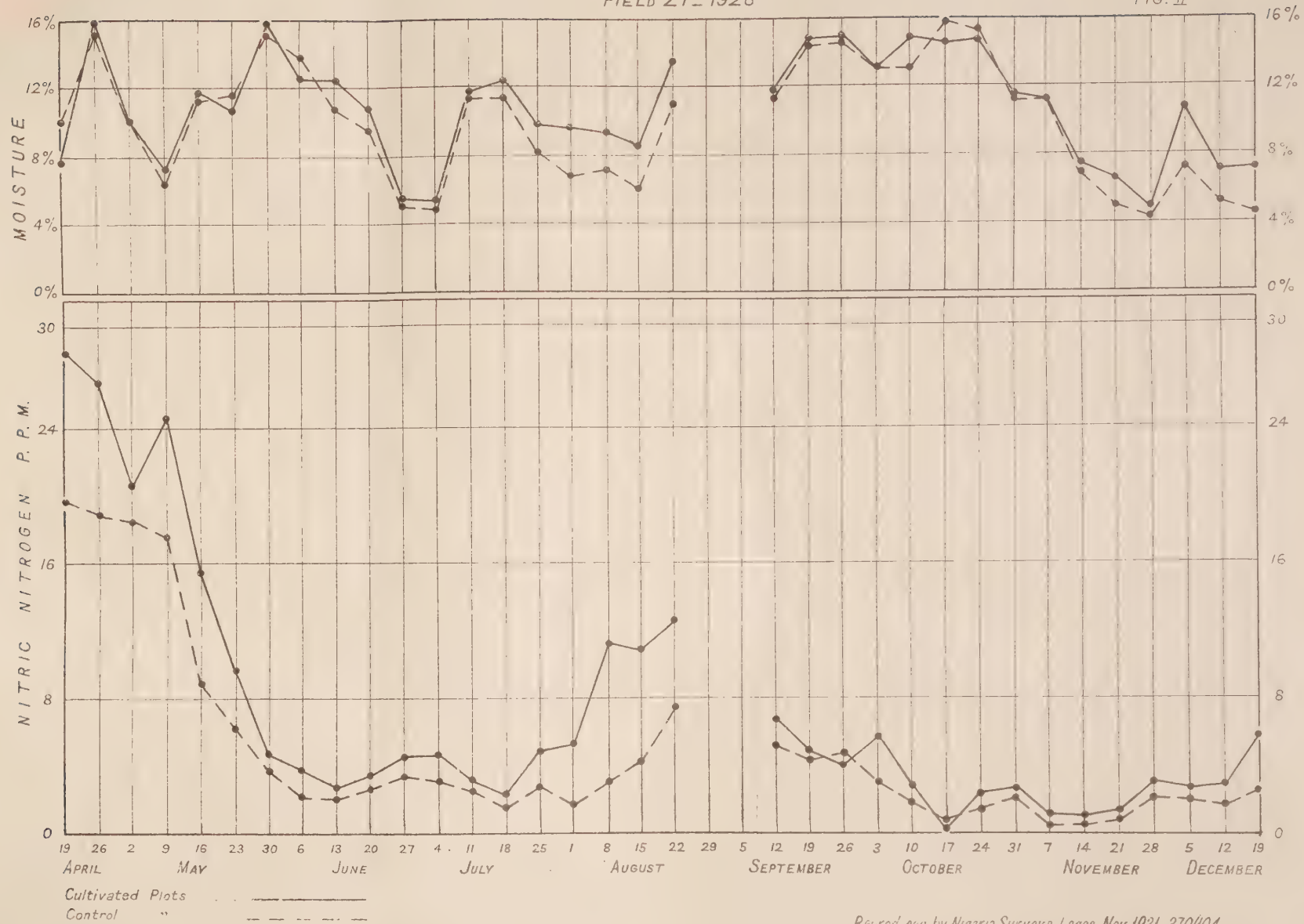
Owing to the late planting and an abnormally dry season—there was no rain after 1st November—the crop on the control plots was a failure. No cobs were set at all. The crop on the cultivated plots was very poor compared with about 500 lb. acre on neighbouring unmanured plots, but most plants matured and produced a small cob. In the circumstances it is not possible to say whether this difference was due entirely to conservation of moisture on the cultivated plots or whether the greater accumulation of nitric nitrogen on these was also concerned. As this accumulation was so high on both sets of plots, one is inclined to attribute the whole difference to the effect of a better supply of moisture.

TABLE No. III.
CULTIVATION EXPERIMENT, FIELD Z1, 1928.
WEEKLY DETERMINATIONS OF MOISTURE (%) AND NITRIC NITROGEN (ppm).

Date.	Plot 2.		Plot 3.		Plot 6.		Plot 7.		Plot 10.		Plot 11.	
	Moist.	Nit.	Moist.	Nit.	Moist.	Nit.	Moist.	Nit.	Moist.	Nit.	Moist.	Nit.
18th April	9.5	19.5	7.9	16.3	5.3	26.4	11.8	22.7	8.5	38.7	10.4	19.7
20th April	14.7	38.1	14.8	17.6	17.4	21.2	16.2	20.9	15.0	20.6	14.7	17.6
2nd May	9.2	16.7	10.0	15.3	11.1	28.1	9.2	18.5	8.7	16.1	10.4	22.3
9th May	7.0	31.2	5.9	15.9	8.0	27.2	5.7	23.9	6.8	15.0	6.8	12.9
16th May	11.7	20.4	11.3	9.0	11.8	13.8	10.1	18.4	11.8	13.6	13.9	9.3
23rd May	10.0	7.8	12.8	9.2	10.6	11.2	10.3	7.8	11.2	10.2	11.5	24.9
30th May	15.2	4.1	16.1	3.9	18.0	5.5	14.8	4.1	14.5	3.5	17.2	3.5
6th June	11.5	2.8	12.0	2.5	13.6	4.0	19.0	1.8	12.3	4.6	10.4	2.2
13th June	10.5	3.1	11.2	2.0	12.4	2.9	10.5	1.7	13.8	2.3	10.3	2.2
20th June	10.1	2.5	10.5	2.2	8.4	2.3	8.4	1.9	9.5	2.8	9.9	2.5
27th June	6.3	5.3	7.0	3.0	7.4	4.0	6.3	3.2	6.7	4.3	6.2	3.5
4th July	5.3	4.2	6.0	3.2	6.2	4.5	4.9	2.1	5.8	4.5	5.2	3.2
11th July	12.4	3.4	12.8	2.3	12.6	3.4	11.7	11.7	10.8	2.2	11.0	3.4
18th July	12.4	3.1	13.4	2.0	12.7	2.9	10.5	1.7	11.2	2.2	9.9	2.0
25th July	10.3	6.4	9.2	2.5	9.6	3.9	7.3	3.0	9.3	4.7	7.9	3.8
1st August	11.2	5.1	6.9	1.9	8.7	7.1	6.2	1.9	9.5	5.0	6.9	2.1
8th August	8.8	12.0	6.9	2.4	10.3	11.7	6.7	3.5	9.6	11.0	7.3	3.5
15th August	7.7	8.9	5.2	2.6	8.8	13.1	5.0	4.7	8.2	10.9	5.7	5.3
22nd August	13.3	8.1	11.0	5.1	14.4	12.9	10.9	6.7	13.0	16.1	10.9	6.7
29th August	No samples taken											
5th September	No samples taken											
12th September	11.9	6.8	12.7	4.0	13.2	8.1	10.5	6.7	10.3	6.1	12.0	6.3
19th September	15.4	5.8	15.4	4.7	15.3	5.3	13.4	5.4	13.5	5.2	13.6	4.7
26th September	16.7	5.4	15.2	4.7	13.9	5.2	14.2	4.7	13.3	2.9	14.3	5.3
3rd October	13.4	10.4	13.7	2.9	14.1	3.2	11.9	2.8	12.0	4.5	13.8	4.1
10th October	12.9	4.0	9.6	2.2	17.8	2.4	14.5	1.8	14.2	2.3	14.7	2.0
17th October	16.3	2.0	17.0	1.5	14.9	1.5	15.6	1.5	13.7	2.0	15.2	2.0
24th October	13.5	2.5	16.6	1.5	16.0	3.0	12.9	1.5	14.0	2.0	15.6	2.5
31st October	11.2	3.0	9.7	2.5	11.2	3.0	10.0	2.0	10.0	3.0	11.4	2.5
7th November	11.8	1.5	12.5	1.0	12.7	1.8	10.2	1.0	9.8	1.5	11.4	1.0
14th November	5.6	1.0	7.2	1.5	9.5	1.8	6.6	1.0	8.7	1.5	6.9	1.5
21st November	5.0	1.5	5.1	1.5	8.1	2.0	5.6	1.3	6.7	2.0	5.6	1.5
28th November	5.0	3.0	4.4	2.5	4.4	3.0	3.9	2.5	4.9	3.5	4.3	2.5
5th December	10.0	2.0	7.9	2.0	11.0	3.5	7.1	3.0	9.9	3.5	7.0	2.3
12th December	7.7	3.5	6.3	2.0	7.6	2.5	5.2	1.5	6.5	4.0	6.3	2.5
19th December	6.4	6.0	5.2	2.0	8.4	7.0	4.2	2.5	5.2	5.0	4.2	4.5

CULTIVATION EXPERIMENT FIELD Z1 - 1928

FIG. II



II.—DETAILED WORK 1928.

In view of these results it was decided to carry out a more complete experiment throughout the 1928 growing season. This allowed for work on both an "early" and a "late" maize crop, planted at normal times, on the same land. Three treatments were decided on:

- (a) *Control*.—no hoeing, but weeds to be cut down when necessary.
- (b) *Well farmed*.—to be treated according to normal practice, *i.e.*, intermediate between (a) and (c).
- (c) *Frequently cultivated*.—to be hoed once a week.

At the beginning of April thirteen plots of about one-twentieth of an acre each were set out as follows:—

- Plot 1 Control
- 2 Frequently cultivated
- 3 Control
- 4 Well farmed
- 5 Control

and so on. The plots

were ridged on the 8th and 9th April and the maize was sown on the 17th. After this the frequently cultivated plots were hoed every Tuesday morning and soil samples were taken from them and adjacent control plots every Wednesday morning. Determinations were made of moisture content and nitric nitrogen.

This crop was harvested on 14th August. The ridges were moulded up on 8th September and the second crop of maize was planted on the 10th. It was harvested on 2nd January.

The results of these laboratory determinations are shown in Table 3, and the crop yields in Tables 4 and 5. Figure II shows the variation in the weekly averages of moisture content and nitric nitrogen.

DISCUSSION OF LABORATORY RESULTS.

The difference in moisture contents between the two series is first appreciable in the "Little dry season" in August when the drying out is noticeably less in the cultivated plots. This must be partly a fallow effect, as during June less rain fell than in August, but the fall in moisture content on both sets of plots was the same in the former month. Presumably in June most of the loss of water was through the plant and so was unaffected by cultivation, whereas during the latter part of July and August, when the crop has ceased growing, the loss of water depended on the state of the surface of the soil.

TABLE IV.
CULTIVATION EXPERIMENT, FIELD Z1, 1928.
YIELDS OF EARLY MAIZE CROP.

Plot.	Grain lb/acre.	Straw lb/acre.	lb grain/100 lb straw.
1. Control	2,180	not recorded	
2. Frequent Cultivation	2,240		
3. Control	1,670		
4. Well farmed	1,965		
5. Control	2,210		
6. Frequent Cultivation	2,440		
7. Control	1,990		
8. Well farmed	2,040		
9. Control	2,085		
10. Frequent Cultivation	2,340		
11. Control	2,430		
12. Well farmed	2,430		
13. Control	2,060		

Mean of all controls 2,085 lb/acre $R = 380$

" increase on 3 frequent cultivation plots 247 lb/acre ± 155 lb ($x/s = 1.6$)

" " " 3 well farmed plots 66 lb/acre ± 155 lb

TABLE V.
CULTIVATION EXPERIMENT, FIELD Z1, 1928.
YIELDS OF LATE MAIZE CROP.

Plot.	Grain lb/acre.	Straw lb/acre.	lb grain/100 lb straw.
1. Control	650	2,280	28.5
2. Frequent Cultivation	1,002	2,900	34.6
3. Control	570	2,980	19.1
4. Well farmed	880	3,400	25.9
5. Control	710	2,940	24.0
6. Frequent Cultivation	1,080	2,000	54.0
7. Control	566	1,920	29.7
8. Well farmed	900	2,500	36.0
9. Control	760	2,420	31.4
10. Frequent Cultivation	1,060	3,080	34.4
11. Control	660	2,020	32.6
12. Well farmed	790	2,960	26.7
13. Control	670	2,560	26.2

Grain Mean yield of control plots 655 lb/acre $R = 64.6$

" increase of 3 plots frequently cultivated 395 lb/acre ± 37.5 lb ($x/s = 10.6$)

" " " 3 plots well farmed 211 lb/acre ± 37.5 lb ($x/s = 5.6$)

Straw Mean yield of control plots 2,446 lb/acre $R = 385$

" increase of 3 plots frequently cultivated 233 lb/acre ± 222 lb ($x/s = 1.05$)

" " " 3 plots well farmed 480 lb/acre ± 222 lb ($x/s = 2.16$)

" " " 2 plots frequently cultivated (Nos. 2 & 10), 565 lb/acre ± 273 lb ($x/s = 2.07$)

Note: The odds that the observed difference "x" is significant compared with the standard deviation "s" is given below:—

If x/s is below 1.5 not significant

— 1.5 14 : 1

= 1.75 24 : 1

= 2.0 43 : 1

During the growth of the late crop the rainfall and consequently the moisture content, was consistently higher right up to the time the crop starts to mature, than in the previous year. It is interesting to note that after a storm in early December the cultivated plots proved to be better able to take up and conserve the water which fell. This was to be expected in view of the greater looseness of their surfaces.

The nitric nitrogen contents started at a high level on all the plots, but rapidly fell as the rains increased and the crop grew. They were higher throughout the season on the cultivated plots than on the controls, but the differences were great only at the beginning of the season when there was a large amount of organic matter in the soil just starting to decompose, and during the dry period in August. This latter is obviously correlated with the conservation of moisture and is a direct effect of the treatment. The lowness of the nitrate content throughout the second crop period is probably due to the lack of deep cultivation or re-ridging in September.

DISCUSSION OF YIELDS.

During the early part of the season a good maize crop can be expected with a minimum of attention. It is not therefore surprising to find no practical difference between the yields on the control plots and on the well-farmed ones, and the difference in favour of the frequently cultivated plots is more significant than might have been anticipated.

From the exaggerated results in the previous late season a more striking result was expected with the second crop. This was obtained: the well-farmed plots gave about thirty *per cent.* and the frequently cultivated plots about sixty *per cent.* more grain than did the control plots, which themselves carried a crop of 650 lb./acre.

In the 1927 season the improvement effected by cultivation seemed to be due to the conservation of moisture. The explanation for the 1928 season is less obvious. Owing to the nature of the season there was little effect on the moisture content, nor was the accumulation of nitric nitrogen great on any of the plots. This is not necessarily a criterion of the amount produced, as it makes no allowance for the amount removed by the crop—which is only small—or that removed by leaching. On the other hand there was no indication of an excessively free supply of nitrogen, as the ratio of grain to straw was actually much lower on the control and well-farmed plots than on those which were frequently cultivated. The weight of straw on the well-farmed plots was the same as on the frequently cultivated, but carried a much smaller amount of grain. The suggestion, is therefore, that the crop on frequently cultivated

plots was in every way better nourished. Whether the cultivation actually makes mineral constituents in the soil more available, or whether it acts indirectly by encouraging root spread so that the plant draws its nourishment from a greater bulk of soil, the data do not allow us to decide. The full effect of cultivation is no doubt complicated and the particular factor which is dominant at any time probably depends on the circumstances of the case.

IV.—SUMMARY.

1. It is shown that frequent cultivation will increase the crop of maize obtainable on Moor Plantation even during the early season when the effect of such treatment would be expected to be a minimum.

2. It is suggested that the effect of cultivation depends on circumstances and is not necessarily limited to conservation of moisture or stimulation of nitrification.

V.—ACKNOWLEDGMENTS.

The writers wish to express their indebtedness to Messrs. Poynter and Brown, the Superintendents in charge of Moor Plantation during the period of these experiments for undertaking the necessary field work.

THE ISHAN COTTON PLANT UNDER MIXED CULTIVATION—II.

BY

E. H. G. SMITH, M.A., AND A. V. GIBBERD, N.D.A.

In a first paper (1), the results of the 1928-29 investigation into the effects of intercropping with yams upon Ishan cotton are recorded. It was then shown that in an important cotton growing district of Southern Nigeria forty *per cent.* of the cotton was intercropped with yams planted some seven months previously. In this second paper the results of the 1929-30 season's work are recorded. The effect of intercropping cotton with yams was again studied with a view to confirming and amplifying the conclusions drawn from the first investigation.

Summarised briefly, these conclusions were as follows:—

- (i) Growth of the plant body (until the yams commence to die off), flower and boll production and yield were depressed some thirty *per cent.*
- (ii) Shape of the plant, shedding, boll weight, period of maximum delivery of the crop and lint length were not affected.
- (iii) The competitive effect of the yam plant was confined to a radius of three feet.
- (iv) There was some evidence for concluding that ginning percentage was depressed.

DESIGN AND OBSERVATIONS.

The previous design of the investigation was followed closely. The experiment again consisted of alternating pure cotton and yam cotton plots of three ridges each, referred to as C and YC plots respectively, with seven replications of each treatment. The length of the ridges was reduced from seventy-two to fifty feet and the positions of the C and YC plots exchanged. Yams of the Alade variety were planted throughout on February 21st, 1929; yams growing in the C plots were uprooted and removed on July 1st and the rows of these plots were moulded up; cotton was planted in all plots on July 9th with the stands two feet apart staggered on the sides of the ridges.

A plan of the experiment is given below :—

Border	...	...	...	2 rows of YC.
Plot 1	...	...	...	Treatment C
„ 2	...	...	...	„ YC
„ 3	...	...	...	„ C
„ 4	...	...	...	„ YC
„ 5	...	...	...	„ C
„ 6	...	...	...	„ YC
„ 7	...	...	...	„ C
„ 8	...	...	...	„ YC
„ 9	...	...	...	„ C
„ 10	...	...	...	„ YC
„ 11	...	...	...	„ C
„ 12	...	...	...	„ YC
„ 13	...	...	...	„ C
„ 14	...	...	...	„ YC
Border	...	...	...	2 rows of YC.

The observations made are similar to those recorded in the first paper and are as follows :—

1. *Growth of Main Axis*.—Stem heights measured weekly on certain plants.
2. *Flowering*.—Counted daily on the middle row of each plot.
3. *Bolls*.—Counted weekly at harvest for all middle rows.
4. *Yield*.—Weight of seed cotton picked weekly recorded separately for each row.
5. *Special Plants*.—Detailed observations were made on two groups of twenty plants each, one C, one YC.
6. *Mean Maximum Lint Length*.—Determined weekly for a sample of seed cotton from C and YC middle rows.
7. *Ginning Percentage*.—Obtained weekly for C and YC as for lint length.
8. *Yield of Yams*.—Weight of tubers recorded separately for each YC row.
9. *Incidence of Disease*.—Weekly census.
10. *Rainfall*.—Recorded daily.

PRESENTATION OF DATA.

The data obtained from these observations are now presented with reference to that obtained during the previous investigation. The results of certain observations, which agree closely with those of last season, are excluded.

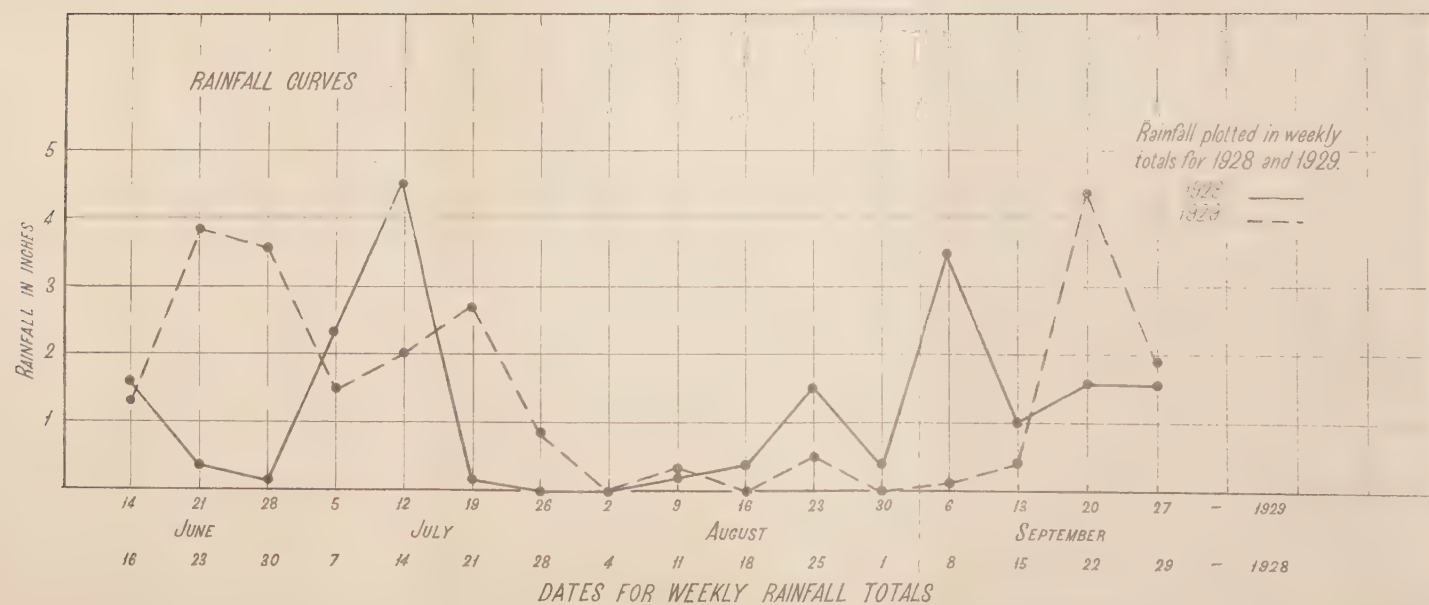
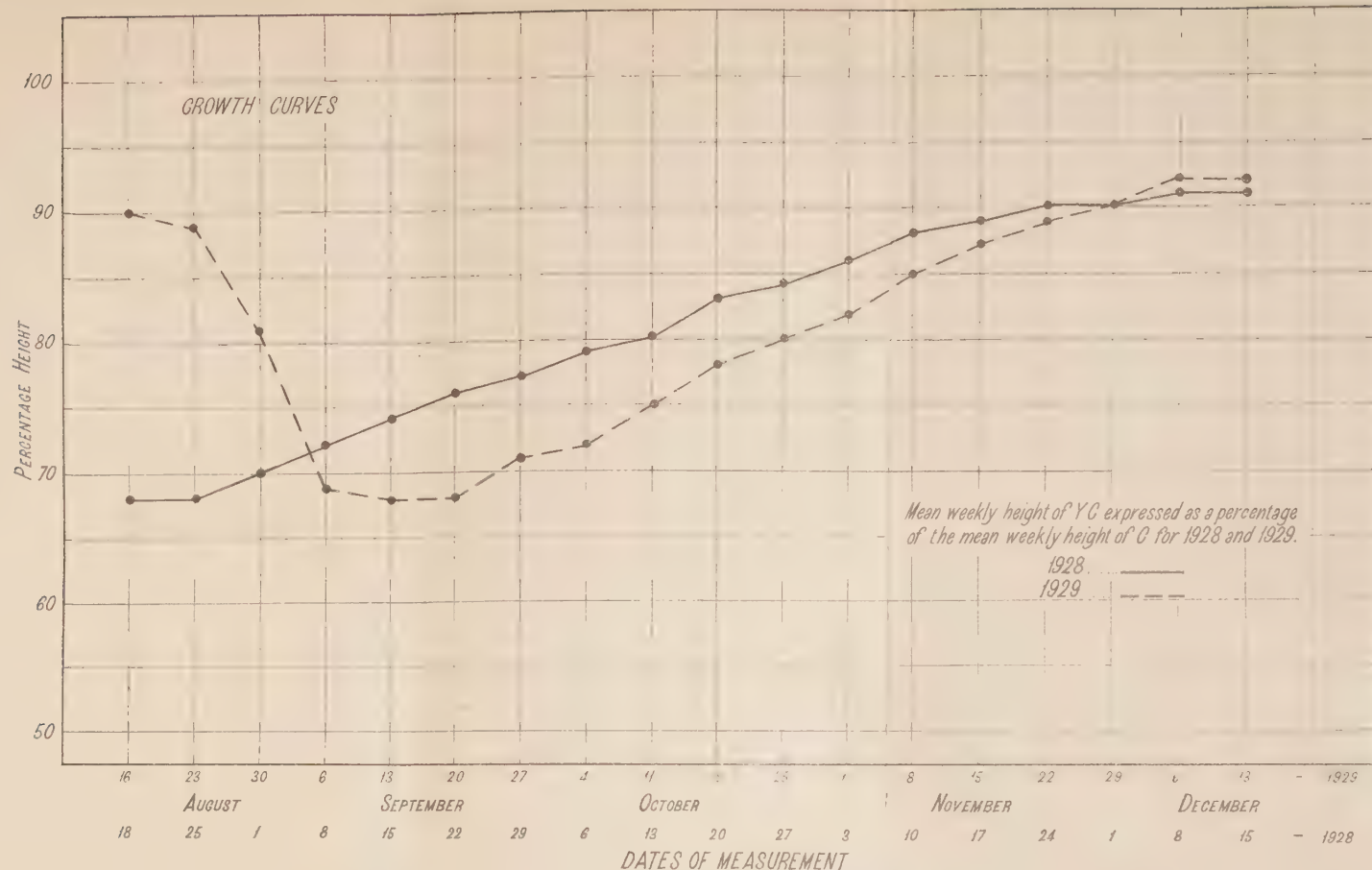
GROWTH OF THE MAIN AXIS.

This percentage height is also plotted in the upper half of Figure I. In the lower half of Figure I the weekly rainfall from June to September for 1929 and for 1928 is shown. It is seen that while during both years the mean height of YC, expressed as a percentage of C, is at one time depressed by approximately thirty *per cent.*, the time of this maximum depression differs. In 1928 the maximum depression (68%) occurs during the middle of August, at the time of the commencement of measurements, and thereafter a gradual recovery in the height of YC takes place until, at the cessation of growth the height of YC is ninety-one *per cent.* of C. In 1929, the height of YC is ninety *per cent.* of C during mid August, the percentage height of YC then rapidly declines during the weeks ending August 30th and September 6th to reach the same minimum as before (68% of C) during the weeks ending September 13th and 20th. That is, in 1929, the height of YC as a percentage of C reached the same minimum four weeks later than in 1928. Thereafter, recovery is more rapid than during the previous season and the YC 1929 curve overtakes the YC 1928 curve towards the end of November. At Ibadan, an annual break in the rains occurs, called the short dry season, commencing sometime during July and of a normal duration of from three to four weeks. In 1928, this period extended from the middle of July until the middle of August. In 1929, good rains were experienced up to the end of July but thenceforth, except for two days towards the end of August when altogether less than half an inch fell, there was little rain until after the middle of September. In 1929, the August rainfall, 0.77 inches as opposed to an average for the past twenty years of 3.25 inches, was abnormally low. In 1929 and 1928, as is shown in Figure I, the time of maximum depression of the YC curve occurs at the end of the respective short dry seasons.

Thus the depression of the height of YC may be sub-divided as follows; firstly, a basic depression of some ten *per cent.* due to the competition of the yams for the available plant food and from the effect of which there is no recovery; secondly, a variable retardation due to competition for the available soil moisture during the short dry season. This retardation increases rapidly in the early weeks of the plant's growth to reach a maximum towards the end of the short dry season when competition for the available soil moisture is most acute between the established and strong growing yam, and the recently sown cotton. The retardation is approximately twenty *per cent.* when at its maximum which, with the basic depression of ten *per cent.* already mentioned, gives a total depression at this time in the height of YC of thirty *per cent.* of the then height of C. With the return of the rains, moisture ceases to be a limiting factor and the YC plants achieve a gradual recovery subject only to the basic ten *per cent.* depression already referred to.

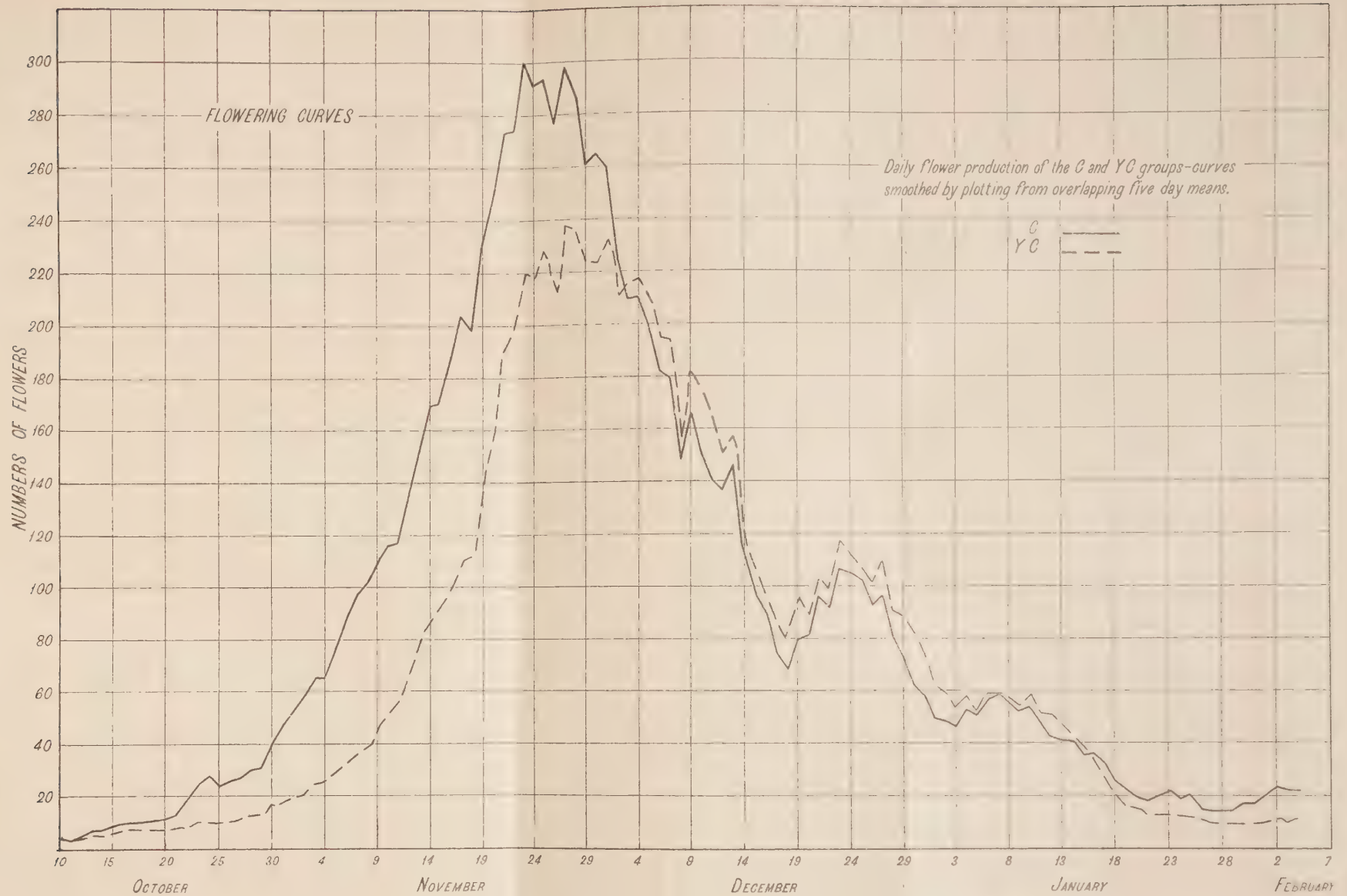
GROWTH AND RAINFALL

FIG. I



FLOWER PRODUCTION

FIG II



Produced by Nigeria Surveys, Lagos Nov 1931 370/104

FLOWERING.

Flowers produced were counted daily on the middle rows of each plot as described in the first paper (1). As in 1928, the ratios of YC to C flowers are low during the last week of October and early in November. From the middle of November the ratio gradually increases until at the end of the first week in December, more YC than C flowers are produced. In the succeeding five weeks, YC flowers exceed those of C, with the ratio reaching a maximum on January 5th of 120, after the middle of January the ratio again falls below 100. During the time that the YC : C ratio exceeds 100 the weekly totals of flowers for both groups are falling off, this limits the recovery of the YC flowering. In 1928 the YC : C ratio was not as high, and a maximum of only eighty-eight *per cent.* was reached. YC flowers produced for the whole season were 82.5 *per cent.* of C as opposed to sixty-five *per cent.* in 1928.

Figure II gives the flowering curves for both groups smoothed by drawing from overlapping five day means. Both curves reach the peak during the latter half of November, some three weeks earlier than in 1928. The curves take the normal form for indigenous cotton at Ibadan except that the modes are reached rather early. The depression that occurs for both curves during the middle of December can probably be accounted for as the effect of the "harmattan", the dry dust laden wind from the north, that occurred in December and which reduces the humidity. The depression of the YC curve due to intercropping is confined to the period from the middle of October to the end of November. From the beginning of December the curves agree closely. The abnormal early rise that occurred in the C curve in 1928 is not repeated. It has been pointed out in the first paper that this was peculiar to that season and, as far as the authors are aware, that is the only season during which this phenomenon has been observed in the years during which the flowering of indigenous cotton at Ibadan has been studied. While, as in 1928, flowering for both groups reached the maximum in the same week, it appears from the daily flower counts and from the flowering curves that there is a slight lag in the YC flowering of less than one week. In 1928 the curves were coeval. Golding (2) and (3), working at Ilorin, found that the effect of planting Ishan cotton through yams was to retard flowering from three to four weeks in 1927, and by about two weeks in 1928. In the latter season at Ilorin the flowering peaks of both pure cotton (C), and intercropped cotton (YC), occurred in the same week.

SHEDDING.

No direct estimation of square or of boll shedding was made in this investigation except that data were obtained from observations on two groups of some twenty plants each, one C and one YC. These data are given separately in Table II for the sympodia (fruiting branches) and monopodia (vegetative branches) of the two groups

TABLE II.

Observations on Square Shedding, Flowering and Bolling for two groups of some twenty plants each, one C, one YC.

Sympodia (Fruiting Branches).	C.	YC.
Average number of buds per plant	81·0	77 2
Average number of flowers <i>i.e.</i> bolls per plant	28·8	37·9
Percentage of flowers to buds	35·5%	49·1%
Average number of squares shed	52·2	39·3
Percentage of squares shed to buds	64·5%	50·9%
Average number of bolls shed per plant	9·9	12·1
Percentage of bolls shed to flowers	34·4%	31·9%
Average number of bolls mummied per plant	1·8	2·2
Percentage of bolls mummied to flowers	6·0%	5·8%
Average number of bolls harvested per plant	17·0	23·5
Percentage of bolls harvested to flowers	59·0%	62·0%
Monopodia (Vegetative Branches).		
Average number of flowers <i>i.e.</i> bolls per plant	30·5	19·5
Average number of bolls shed per plant	8·0	5·1
Percentage of bolls shed to flowers	26·2%	26·2%
Average number of bolls mummied per plant	0·9	1·0
Percentage of bolls mummied to flowers	3·0%	5·1%
Average number of bolls harvested per plant	21·6	13·3
Percentage of bolls harvested to flowers	70·8%	68·3%
Average total number of bolls harvested per plant ...	38·6	36·8
Percentage of total crop born by :—		
{ <i>a.</i> sympodia	44%	64%
{ <i>b.</i> monopodia.	56%	36%

It is unfortunate that the YC group of twenty plants has produced an average of ninety-five *per cent.* of the total bolls of the C group as opposed to a ratio of seventy-seven *per cent.* for the bolls harvested from the whole of the middle rows. That is to say these twenty YC plants are atypical and are not a true sample of the entire YC population. Notwithstanding this, the data in Table II is of interest. Taking the mean number of buds produced by the sympodia of each group, C is slightly in excess of YC. Square shedding is markedly heavier with C than YC, with the result that the sympodia of YC have produced more flowers and more bolls than those of C since the percentages of bolls shed and bolls mummied agree fairly closely for both groups. On the monopodia, C flowers exceed those of YC and, with the percentages of bolls shed mummied again almost identical, the bolls on these branches make up the previous deficiency for C and further, enable the total yield of C to exceed that of YC. This heavy shedding of the early buds from the sympodia of C explains the absence in 1929-30 of the early rise in the C flowering curve that was observed the previous season. Mason and Wright (4), drew attention to the tendency of native cotton to postpone the setting of its crop until the termination of the rains and the heavy flower-bud shedding that occurs early in the season. On account of the depression and retardation in growth due to intercropping, the sympodia of the YC plants have not developed as many buds as those of C at this time of maximum flower-bud shedding. Thus square or flower-bud shedding on the sympodia of C is in excess of that with YC. In compensation for this loss of crop from the fruiting branches, the sympodia of C, not subject to the depression and retardation in growth due to intercropping, produce more bolls than those of YC. Reference was made in the first paper to what was then considered the abnormal equal percentage of square shedding observed on the first five fruiting branches (sympodia) for both groups. This accounted for the peculiar early rise in the C flowering curve in 1928 already referred to. These results confirm the suggestion then advanced that, owing to the C group being in a more advanced stage of development than the YC group early in the season, square shedding on the former would exceed that on the latter at this time.

As has been stated, the percentages of bolls shed agree closely for both these groups. In this investigation, the figures for mummied bolls, given in Table II for the two groups of twenty plants, include all bolls that had dried up before attaining their full size (*see* Golding, Lean and Laycock (5)), and bolls which consisted entirely of damaged locks. The various factors responsible for this latter damage were not analysed.

Boll shedding for the entire population of the middle rows was assessed, as last season, by subtracting the number of bolls harvested from the number of flowers produced in each instance. These figures for estimated boll shedding again agree closely for both groups although boll shedding was much less severe than in the previous season.

BOLLING.

The data for the number of bolls harvested weekly from the middle rows and for the mean weekly boll weight in grammes is similar to that obtained in the first investigation and is therefore not included.

Summarised this data shows that :—

- (i) As was observed last season, the bolling peak of both groups occurs in the same week. But there is some evidence, though less than that offered by the study of flowering, for concluding that there is this season also a slight lag in the YC bolling. Again, as with flowering, this is of less than one week.
- (ii) The YC plants of the middle rows produced seventy-seven *per cent.* of the bolls of C as opposed to sixty-seven *per cent.* recorded for last season.
- (iii) The mean boll weights for C and YC are again almost identical, though generally higher than those obtained in the first investigation. The mean weekly boll weights for both groups rise and fall together, with the maximum boll weight occurring in the same week. During the first part of March, the YC mean boll weight fell off somewhat more rapidly than that of C.

YIELD.

The yields of seed cotton per row and per plot, and the weights of yam tubers harvested from the YC rows and plots, are presented in Table III.

TABLE III.

Yields of Seed Cotton (in decagrammes) from the C and YC rows and plots.

(The bracketed figures in italics are yam yields in lb.)

C.			YC.		
Row No.	Row Yield.	Plot Yield.	Row No.	Row Yield.	Plot Yield.
1	254	898	4	178 (47)	595 (161)
2	307		5	176 (61)	
3	337		6	241 (53)	
7	331	1,038	10	233 (54)	818 (143)
8	374		11	372 (34)	
9	333		12	213 (55)	
13	345	977	16	250 (37)	656 (135)
14	303		17	202 (53)	
15	329		18	204 (45)	
19	314	924	22	222 (31)	555 (121)
20	290		23	192 (32)	
21	320		24	141 (58)	
25	232	773	28	223 (49)	568 (147)
26	259		29	194 (40)	
27	282		30	151 (58)	
31	266	792	34	117 (81)	642 (158)
32	247		35	276 (33)	
33	279		36	249 (44)	
37	398	1,068	40	295 (44)	767 (163)
38	362		41	216 (64)	
39	308		42	256 (55)	
Total C ...	...	6,470	Total YC	...	4,601 (1,028)

The data obtained from the yields confirms the previous results. As was observed last season, there is a slight lag with the YC pickings during the early weeks. Otherwise the weekly percentages throughout harvest of the total crop for C and YC agree closely, with the period of maximum delivery of the crop the same for both groups. A small negative correlation of low statistical significance was obtained this year between the yam and the cotton yields of the YC rows. Last season's conclusion that the competitive effect of the yams does not extend beyond a radius of three feet is also confirmed.

The statistical significance of the difference between the C and YC yields of seed cotton per plot may be tested, by Faulkner's method (6). The respective average differences (in decagrammes) are -258 ± 59 and $+276 \pm 55$, which both give odds against a chance occurrence of an error of equal magnitude of over 33,300 : 1. Thus the statistical significance of the observed differences of the plot yields of seed cotton between C and YC is very high.

LINT LENGTH.

Mean maximum lint lengths were measured (in millimetres) each week on the seed cotton harvested from the C and YC plots. The clean seed cotton from the middle rows of each group was bulked and sixty seeds were obtained for measurement by sampling. With certain exceptions, the weekly mean maximum lint lengths of the two groups rise and fall together and the magnitude of the weekly fluctuations are statistically significant, as was observed last season. The weekly excess of C over YC is not however statistically significant. The mean weekly excess is 0.45 mm.

GINNING PERCENTAGE.

Ginning percentages were calculated weekly on samples obtained as described for lint length. While during the first weeks of the harvesting C is slightly in excess of YC, thereafter positive and negative excesses of C over YC occur with equal frequency. There is no evidence from these results for concluding that intercropping is with effect upon ginning percentage.

INCIDENCE OF DISEASE.

A weekly assessment of the incidence of diseases and pests was made from the end of August until the end of November.

Helopeltis bergrothi. Reut, originally described as a minor pest of cotton in Southern Nigeria by Golding (7), was alone of importance. The attacks of this pest are very local in effect and extended to all cotton on Moor Plantation.

DISCUSSION OF THE RESULTS.

It is somewhat unfortunate that the two past seasons, during which the two yam and cotton intercropping investigations were conducted, have been exceptionally favourable for cotton. It would have been of greater interest if 1929-30 had been even only an average cotton year. As it is, the 1929-30 cotton yields on Moor Plantation exceeded all previous records. In both investigations, the cotton yields have been well up to, and the yam yields rather below, the average yields obtained on the Moor Plantation rotation

blocks for the same years. On the other hand it must be pointed out that in 1929-30 yields of 1,140 lb. per acre for cotton grown as a sole crop after early green manure (*mucuna*) and of 883 lb. per acre for cotton intercropping with yams, the latter a good average crop, were obtained from two rotation blocks (8). In this instance, the yield of cotton intercropped with yams (YC) is seventy-seven *per cent.* of that of cotton grown as a sole crop (C). While yields of different blocks are not strictly comparable, these results support the figures for the depression of cotton yield due to intercropping with yams, obtained from the detailed investigations, described in this and the previous paper (1), and further show that similar results are obtainable on a field scale.

The primary casual factor of the depression of cotton yield when intercropped with yams has been shown, in an investigation extending over two seasons, to be the depression and retardation in growth which is at its maximum effect during an early stage of the plant's life. This depression and retardation of growth causes a reduction in flower production, hence bolling and yield are reduced. Balls (9), in his studies on cotton in Egypt, advanced the conception of pre-determination. The depression of the YC flowering from mid-October to the end of November was pre-determined by the earlier depression and retardation of YC growth. This depression and retardation of the YC growth has been analysed into firstly, a basic depression of some ten *per cent.* due to the general competitive effect of intercropping; and secondly, a retardation, at its maximum effect some further twenty *per cent.*, occasioned by competition for the available soil moisture during the short dry season. It has also been shown that the retardation, which is absent in the earliest stage, increases rapidly as the competition for moisture becomes severe during the period without rain and reaches a maximum just before the rains recommence, when competition for the available soil moisture is most acute. Thereafter, a rapid recovery takes place until, when YC is some ninety *per cent.* of C, the operation of the factor causing the basic depression precludes further recovery. Whereas, by the time of cessation of growth, the YC stem height has recovered to ninety *per cent.* of C; data published in the first paper shows that the first eight vegetative branches recover only to the extent of some eighty *per cent.* of the length of those of C. That is to say, the cessation of growth or senescence intervenes before this part of the YC plant body recovers to the full ninety *per cent.* of C permitted by the factor causing the basic depression of ten *per cent.* As a result, this part of the plant body which bears, with Ishan cotton grown as a sole crop, the greater proportion of the flowers is depressed in the neighbourhood of twenty *per cent.* Senescence in growth occurs when YC might have a greater recovery in flowering and the YC flowers are only some seventy to eighty *per cent.* of those

of C. With approximately identical percentages of bolls shed and mummied for both groups, the reduced flower production of YC pre-determines a reduced boll production and therefore a reduced yield. Thus the depression and retardation of YC due to intercropping may be summarised as follows:—

- (i) *Stem Height*.—Basic depression of ten *per cent.* plus a variable retardation with a maximum of twenty *per cent.*
- (ii) *Vegetative Branches*.—Minimum depression of some twenty *per cent.*
- (iii) *Flower Production*.—Depression of some twenty to thirty *per cent.*

Data obtained from the two groups of twenty plants, together with the first season's peculiar rise in the C flowering curve, shows that the square or flower-bud shedding early in the season is not as heavy from the sympodia of YC as it is from those of C. This is accounted for by the depression and retardation in the growth of the YC plants at the time when flowering commences. Data from these two groups further suggests that, as an effect of intercropping, a greater proportion of the total crop is born by the sympodia of the intercropped cotton (YC) than by those of the pure cotton (C) and that, conversely, the opposite is true for the monopodia. Again this is the result of the earlier depression and retardation in growth.

There is some evidence, in the 1929-30 season only, of a slight lag of less than one week in both the flowering and bolling of the intercropped cotton. With this exception, the rate of the delivery of crop is uninfluenced. The yield of YC seed cotton from the middle rows is seventy-six, and from the plots is seventy-one, *per cent.* of that of C, as compared to approximately sixty-seven *per cent.* last season in both instances. Thus it may be concluded that, after allowing for the two excellent cotton seasons, the effect of intercropping with yams is to depress the yield of seed cotton to from sixty-five to seventy-five *per cent.* of that obtainable when cotton is grown as a sole crop. While no evidence of a statistically significant reduction in mean maximum lint length, due to intercropping, can be offered, it may be concluded that intercropping does very slightly reduce the lint length. However, the observed reduction is not of sufficient magnitude to be of any economic importance. Regarding ginning percentage, the observed fluctuations make the results inconclusive.

SUMMARY.

The results of the two investigations, showing some of the effects of intercropping with yams on the Ishan cotton plant, may be summarised as follows:—

1. Due to intercropping there is a basic or primary depression in growth of some ten *per cent.* from which no recovery takes place. A retardation of growth occurs due to competition with the yams for the available soil moisture during the short dry season. This retardation increases rapidly during the break in the rains to reach a maximum of twenty *per cent.* at the end of this period. Thereafter, a gradual recovery takes place which continues until complete recovery has been attained just before senescence occurs. In the first investigation a minimum depression of twenty *per cent.* in the length of the monopodia was observed.

2. As a result of the depression and retardation of growth, flower production, and hence boll production and yield are reduced by from twenty-five to thirty-five *per cent.*

3. The heavy flower-bud shedding, that normally occurs with indigenous cotton before the cessation of the rains, is reduced by intercropping as the development of the intercropped plants is both depressed and retarded at this time.

4. Intercropping increase the proportion of the crop born by the sympodia and decreases the proportion born by the monopodia. Thus the loss of crop occasioned by intercropping occurs from the monopodia alone.

5. There is some evidence (during 1929-30 only) that intercropping slightly retards flowering and bolling. This retardation is of less than one week.

6. There is evidence that intercropping slightly reduces the mean maximum lint length. This reduction is too small to be of economic importance.

7. Intercropping does not affect :—

(i) Shape of the plant (determined in 1928-29 only).

(ii) Boll shedding.

(iii) Mean boll weight.

(iv) Period of maximum delivery of the crop.

8. The data obtained from the study of ginning percentages is inclusive.

9. The competitive effect of the yam does not extend beyond a radius of three feet.

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ANNUAL REPORT,—MOOR PLANTATION, IBADAN, NIGERIA—1929.

The following officers were in charge :—

Mr. D. H. Brown ; January 1st to February 14th, 1929.

„ R. M. Davies ; February 15th to April 22nd, 1929.

Capt. W. B. Dowson ; April 23rd to July 24th, 1929.

Mr. J. R. V. Smyth ; July 25th to December 31st, 1929.

The experimental work carried out on annual crops during the year under review has been a continuation of the programme previously laid down, which has been explained in earlier bulletins. In addition, a groundnut acclimatisation test was started.

In addition to rotational experiments, certain minor experiments have been carried out. A yam mulching experiment on a quarter acre plot indicated that early mulching is most desirable, thus confirming results previously obtained at Ilorin. On other plots the advantages of frequency of cultivation of maize were investigated:

As will be seen from the rainfall table, the year was unusual as regards rainfall. The total recorded was 48·6 inches—only ·83 inches less than the average for the last twenty years—but less rain than usual fell in March, April and May, and there was an exceptionally high fall in June, with abnormally low fall in August. But on the whole, the year was a favourable one for most crops.

Early maize yielded 2,000 lb. per acre on some blocks, but the average over the whole plantation was less than 1,500 lb. Very satisfactory yields of groundnuts were recorded though attacks of Tikka and Rosette disease occurred. The season suited the cotton crop admirably, and there were only isolated cases of Leaf curl and Helopeltis. Yields unprecedented on Moor Plantation were recorded—the best being 978 lb. seed cotton per acre on the Four-year Rotation—while the average throughout the plantation exceeded 500 lb. per acre. Only Ishan cotton was grown, and 88 *per cent.* was sold as grade I.

The yam crop was fairly good but many tubers were found to have abnormally corky skins, which rendered them useless for planting and storing.

TABLE 1.

YIS. COVER CROP EXPERIMENT. COMMENCED 1922.
ACREAGE 3·6.

Cropping.—Maize and beans each year.

Object.—(i) To study the effect of various treatments during the dry season.

(ii) To compare the efficiency of various legumes as late season Cover crops.

Routine.—Beans ridged in, in March ; maize planted in April ; beans interplanted in June.

	Yields of early maize in lb. dry grain per acre.	Odds that the difference is significant.
Average yield of 10 plots following Dolichos... ..	1,190	—
Average difference of 2 plots following Canavalia	-154±178	4 : 1
Average difference of 2 plots following Mucuna	- 25±178	—
Average difference of 2 plots following Cowpeas... ..	+ 0±178	—
Average difference of 1 plot following Dolichos dug December 1st	+ 33±252	—
Average difference of 1 plot following Weeds, dug December 1st	+173±252	3 : 1
do. do. do.	-114±252	--

Mucuna again afforded the best cover, while cowpeas and canavalia were of little value ; dolichos supplied a good cover, though not quite as good as mucuna. The yield of early maize was not good ; the decrease, compared with previous years, may be partly accounted for by the lack of rain during the early stages of growth. The yields recorded during the last six years are shown in the following table :—

	1924 lb.	1925 lb.	1926 lb.	1927 lb.	1928 lb.	1929 lb.
Average yield of 10 plots after Dolichos	1,255	(546)	1,243	1,337	1,337	1,190
Average difference of 2 plots after Canavalia	+ 42	- 10	-171	-225	-285	-154
Average difference of 2 plots after Mucuna	-115	- 18	-111	- 92	- 83	- 25
Average difference of 2 plots after Cowpeas... ..	-203	+ 31	-145	-123	- 59	—
Average difference of 1 plot after Dolichos dug in, in December 1st	+223	+186	+ 54	- 95	- 98	+33
Average difference of 1 plot after Weeds	-311	-146	-516	-464	+133	+173
Average difference of 1 plot cultivated December 1st and January 1st	-225	- 70	-311	-172	-345	-144

It appears probable that the level of fertility of the dolichos plots is being maintained, though it is not yet possible to draw definite conclusions. It will be noted that although mucuna afforded the best cover, the yield of maize after dolichos continued to be higher, though to a diminishing degree.

TABLE 2.

B7 & 8. DRY SEASON TREATMENT OF COVER CROP EXPERIMENT.

COMMENCED 1925—ACREAGE $4\frac{1}{4}$.

Cropping.—1925–1930. Maize and mucuna each year.

Object.—To compare the effect of digging in a cover crop green with that of allowing it to stand and mature during the dry season.

Routine.—“Even” plots (2–16), cover crop to be cut in March and dug in at once.

“Odd” plots (1–17) cover crop to be cut in October and dug in at once.

Maize planted in April, mucuna interplanted in June.

	Yields of early maize in lb. dry grain per acre.	Odds that the difference is significant.	
Average yield of 9 plots dug in at the beginning of the dry season—31st October, 1928	1,974	—	
Average difference of 8 plots dug in at the end of the dry season—7th March, 1929	−121±54	100 : 1	
<i>Yields:—</i>			
1926.	1927.	1928.	1929.
2,308	1,652	1,903	1,974

The results obtained during the previous three years were confirmed by this year's figures, which were greater than those recorded in 1927 and 1928, but less than those for 1926. There is a strong indication that a heavier crop of maize is obtained when it follows mucuna buried at the beginning of the dry season, than after mucuna buried at the end of the dry season. This may be due to the fact that mucuna dug in during October or November decays completely, and consequently, a firm seed bed is obtained.

TABLE 3.

C5N. TREATMENT OF COVER CROP EXPERIMENT.

COMMENCED 1925—ACREAGE 5.

Cropping.—1926–1930. Maize and mucuna each year.

Object.—(i) To compare the effects of digging and moulding up, as methods of preparatory cultivation.

(ii) To compare the effects of digging in the cover crop green, and of allowing the cut cover crop to remain on the surface to rot before digging in.

Routine.—Plot 1. Cover crop cut in February and dug in at once.

Plot 2–10. Cover crop to be burnt in February, the “Even” plots to be ridged and “Odd” plots moulded.

Plots 11–19. Cover crop cut in November, then “Odd” plots to be ridged immediately, and “Even” plots left to rot, to be ridged in February. (Cover crop on five ridges of each odd plot to be weighed before ridging).

Plot 20. Cover crop to be burnt in February and ridged at once.

Maize planted in April, mucuna interplanted in June.

	Yields of early maize in lb. dry grain per acre.	Odds that the difference is significant.
Average yield of 5 plots Cover Crop burnt in February and then ridged ...	1,741	—
Average yield of 4 plots Cover Crop burnt in February and then moulded	— 229 ± 44	α
<i>Yields:—</i>		
1926.	1927.	1928.
2,098	1,523	1,622
+ 30 ± 30	+ 99 ± 67	— 105 ± 47
		— 229 ± 44

As in 1928 better yields were obtained from those plots on which the cover crop was burnt and ridged in, than on those where it was burnt and moulded in.

	Yields of dry grain in lb. per acre.	Odds that the difference is significant.
Average yield of 5 plots Cover Crop cut in November and ridged in at once ...	1,914	—
Average difference of 4 plots Cover Crop cut in November and ridged in March	— 145 ± 145	5 : 1
<i>Yields:—</i>		
<i>1926.</i>	<i>1927.</i>	<i>1928.</i>
2,269	1,631	1,908
—22±122	—169±128	—102±112
		—145±145

These figures agree with previous results, though once again the difference is not significant. They appear to follow the results obtained from the Dry Season treatment of cover crops mentioned above (Table II), but in that case, the mucuna was not cut in November, but was allowed to mature.

TABLE 4.

B3E.—GREEN MANURING EXPERIMENT.

COMMENCED 1923—ACREAGE $3\frac{1}{4}$.

Object.—To compare the efficiency of various leguminous crops for the purpose of green manuring.

Cropping.—Beans and late maize each year since 1923 with the exception of 1924 and 1926 when cotton replaced late maize.

Routine.—Late maize harvested, stalks removed, beans planted in March stand 1 foot apart on each side of the ridge. Beans to be dug in August. Late maize planted in September. Mucuna “Odd” plots, Amberique beans, plots 2 and 8; Centrosema plots 4 and 10; Calopogonium plots 6 and 12.

	Yields of late maize in lb. dry grain per acre.	Odds that the difference is significant.
Average yield of 7 plots following Mucuna	1,540	—
Average difference of 2 plots following Dolichos	-128 ± 114	6 : 1
Average difference of 2 plots following Lima	-366 ± 114	1,500 : 1
Average difference of 2 plots following Calopogonium	- 81 ± 114	3 : 1

	1923.	1925.	1927.	1928.	1929.
Mucuna ...	1,053	1,054	1,356	1,601	1,540
Dolichos ...	+ 86	- 23	+ 41	-174	-128
Canavalia ...	+ 46	+ 26	-110	-237	(Lima) -366 (Calopogonium)
Cowpeas ...	+ 64	-126	- 38	-104	- 81

The crop of late maize on this block was the best on the plantation; the average yield on the control Mucuna plots was slightly below last year's yield—the highest recorded since the experiment was started—but the green manures were turned in later than was desirable, and as a result, a poor seed bed was obtained.

This year, Lima beans and Calopogonium were substituted for Canavalia and Cowpeas respectively. Mucuna and Dolichos formed good covers early, but the growth of Lima beans was unsatisfactory throughout the growing period, and ultimately proved a complete failure. Calopogonium was slow in establishing itself, but later, with suitable falls of rain, its growth was very satisfactory and it soon formed a thick close cover, which continued until it was turned in.

It will be seen from the following table, which shows the approximate weight, in pounds per acre, of green manures dug in on 14th August, that despite the late establishment of Calopogonium, it supplied the heaviest quantity of green manure.

Crop.	1927.	1929.	Crop.
Mucuna	17,380	15,738	Mucuna.
Dolichos	13,530	11,968	Dolichos.
Cowpeas	3,630	20,614	Calopogonium.
Canavalia	2,640	5,478	Lima.

TABLE 5.

D5N —GROUNDNUTS, 1929. 'RIDGING' *versus* MOULDING'
EXPERIMENT. MAIN ROTATION—ACREAGE 5. COMMENCED 1922.

Object.—To compare ridging with moulding as preparatory cultivations for groundnuts.

<i>Rotation.</i> —		(1925) (1929)	Groundnuts and Beans	(1926 Maize and (1930) Cover Crop.
		(1927) (1931)	Yams and Cover Crop	(1928) Cotton and (1932) Cover Crop.
		Weight of dry unshelled nuts in lb. per acre.		Odds that the difference is significant.
Average yield of 10 plots ridged		...	1,417	—
Average difference of 9 plots moulded		+	5 $\pm$ 54	—

This experiment was similar to that carried out in 1928, and confirms the results then obtained. There appears to be little difference between ridging and moulding as regards yield, but economically, moulding has the advantage. In addition, earlier planting is possible if the land is moulded, instead of ridged.

TABLE 6.

D6S.—GROUNDNUTS 'ACCLIMATISATION' TEST.
MAIN ROTATION—ACREAGE 5.

Object.—To compare newly-imported Zaria groundnuts, with once grown, or acclimatised Zaria groundnuts.

		Average yield of dry undecorticated nuts in lb. per acre.		Odds that the difference is significant.
Average yield of 10 plots				
Acclimatised (once grown)				
Zaria seed	... ..	...	1,370	—
Average difference of 9 plots				
Newly-imported Zaria seed	...	—	50 $\pm$ 41	7 : 1

This is the first of a series of experiments laid down in 1928, the object being to investigate whether higher yields are obtained from groundnuts newly imported from Zaria or from those grown for one, two, three or four years on Moor Plantation. New seed from Northern Nigeria has always done well here, but yields have apparently decreased as it has become acclimatised.

TABLE 7.

A7S.—YAMS—1929. 'TIME OF PLANTING TEST.'

ACREAGE 5.—BLOCK CROPPING.

Rotation.—1928 green manure till October. 1929 yams and cotton. 1930 early and late maize; green manure sown July.

	Average yield in lb. per acre.	Odds that the difference is significant.
Average yield of 10 (Control) plots planted 23rd November, 1928	6,652	—
Average difference of 5 (Treatment) plots planted 31st December, 1928	- 4,138 ± 302	α
Average difference of 4 (Treatment) plots planted 8th February, 1929	- 1,374 ± 338	33,300 : 1

December 31st was a date specially selected because of the severe 'harmattan' conditions existing at the time, while the planting on February 8th was a day after a storm of rain. From the results of this experiment there seems little doubt that planting at the end of the wet season is preferable to later planting, but that it is better to plant in February, than during the 'harmattan.'

TABLE 8.

Z5. N & S YAMS—MAIN ROTATION.

ACREAGE—10.

Object.—To compare yields from four varieties of yam.

Rotation.—(1925) Yams and Mucuna (1926) Green Manure
(1929) (1930) and Cotton.
(1927) Groundnuts and (1928) Maize and Cover
(1931) Cover Crop. (1932) Crop.

This variety test was carried out with the same varieties as were used in 1927. Germination was uneven—Iyawo germinating rapidly, while Esinmerin was very slow. As in 1927, Esinmerin gave the highest yield; this variety is said to store well, but it is not very popular in the district.

PERMANENT CROPS.

The acreage under permanent crops has remained the same and tables in the appendix show the yields for comparison with previous records.

TABLE 9.

COCONUTS, 1929.

A slight decrease on 1928 records marks the yields from B1, and a slight increase is recorded from C1, the total yields, however, just fall short of last year's figure.

TABLE 10.

COCOA, 1929.

Higher yields were recorded from both areas under cocoa, the average yield over all being 632 lb. of dry (good and bad) beans per acre as compared with 303 lb. good beans per acre in 1928. The beans harvested from the cocoa crop were all utilised for cocoa fermentation experiments carried out by the Senior Mycologist, and sold later to Messrs. The Cocoa Manufacturers, from whom reports on the various treatments are expected.

COFFEE, 1929.

A yield of 133 lb. parchment coffee was obtained from one acre of Abeokuta coffee, and this, with small quantities of Liberian and Brazilian coffee, was used for fermentation experiments.

TABLE 11.

KOLA, 1929.

The yield of good nuts from the two-and-a-half acres of Gbanja kola was the best recorded since 1926, but many of the nuts were of an inferior quality, being small and malformed, as was the case in 1928.

The following table shows the yields for previous years :—

Year.				Good nuts, lb.
1923	...	...	...	80
1924	...	...	...	114
1925	...	...	...	349
1926	...	...	...	466
1927	...	...	...	109
1928	...	...	...	88
1929	...	...	...	327

The marked increase in yield over that recorded last year may be due, in part, to "slashing"—an operation common amongst native farmers, and carried out with the object of increasing yields. The kola on this block is somewhat closely planted and this may account for the low yields: thinning will take place during 1930.

NURSERY, ORCHARD, ETC.

Owing to the new water scheme not having been extended to the Nursery in Y5, and the previous supply of water no longer being available there, nursery activities have now been transferred to roughly two acres of land in Z6, S.W., through which area runs a stream, which should give a sufficient supply of water throughout the year, except possibly in a very dry season. In this area 240 beds have been made and planted up with fruit seedlings, economic trees, ornamental shrubs, bushes, plants and creepers. Particular attention is being paid to the production of economic trees such as kola, coffee, cocoa, budded and grafted fruit trees, for which a large demand is received annually.

The following plants were distributed in 1929 :—

Coconut palms	...	...	38
Kola plants	...	...	34
Coffee	...	...	147
Fruit trees	...	...	3,219
Ornamental plants	...	...	7,363

POULTRY : BREED—RHODE ISLAND RED.

A general reorganisation has taken place ; the six former pens have now been divided up into eighteen smaller pens, and seventeen permanent buildings erected in place of the former bush houses. Fresh stock was introduced from England during July in the form of twelve hens and eight cockerels. Native hens are kept only for setting purposes. It is hoped to build up the stock during the next year or eighteen months in order that the many demands for English birds and eggs may be met. On the whole the stock has been healthy, though there have been outbreaks of chicken-pox. Little trouble has been experienced from lice since the erection of the new buildings.

The poultry received a ration of fresh-ground bones daily, also guinea-corn, gero, grit, occasionally maize, and, in addition, green food, such as lettuce and cabbage, when available.

984 eggs and five cockerels were sold during the year.

TABLE No. 1.

YI. S. COVER CROP EXPERIMENT, 1929.

(3.6 acres.)

Plot.	Treatment.				Yield per acre.		Increase (+) or decrease (-) compared with mean of adjacent controls.
(18 acres)							
21	Dolichos	...	...	...	972		
22	Canavalia	...	...	...		1,103	- 156
23	Dolichos	...	...	...	1,546		
24	Mucuna	...	...	...		1,278	- 122
25	Dolichos	...	...	...	1,254		
26	Cowpeas	...	...	...		1,133	- 33
27	Dolichos	...	...	...	1,078		
28	Canavalia	...	...	...		881	- 153
29	Dolichos	...	...	...	990		
30	Mucuna	...	...	...		1,135	+ 72
31	Dolichos	...	...	...	1,136		
32	Cowpeas	...	...	...		1,135	+ 33
33	Dolichos	...	...	...	1,068		
34	Dolichos (December 1st)	...	...	...		1,244	+ 33
35	Dolichos	...	...	...	1,354		
36	Weeds	...	...	...		1,495	+ 173
37	Dolichos	...	...	...	1,288		
38	Weeds (December 1st)	...	...	...		1,138	- 114
39	Dolichos	...	...	...	1,216		
40	Dolichos	...	...	...			Non-experimental.
Average					1,190		

Average yield of 10 plots with Dolichos				...	...	1,190 lb.
"	difference	"	2	"	"	Canavalia -154±178
"	"	"	2	"	"	Mucuna - 25±178
"	"	"	2	"	"	Cowpeas 0±178
"	"	"	1	plot	"	Dolichos (Dec. 1st) ... + 33±252
"	"	"	1	"	"	Weeds +173±252
"	"	"	1	"	"	Weeds (December 1st) -114±252

Variety—Lagos White.

Planted March 27th.

Thinned April 29th, 1929. Ridged March 1st, 2nd and 4th. Weeded April 19th, May 15th, June 14th, July 11th. Ridged and cultivated December 1st.

Cultivated January 2nd. Supplied April 9th.

Cost in man-days per acre = 109.

TABLE No. 2.

B7. & 8. DRY SEASON TREATMENT OF COVER CROP EXPERIMENT, 1929.

(4 $\frac{1}{4}$ acres.)

Plot.	Treatment.							Yield per acre. lb.	Increase (+) or decrease (-) com- pared with mean of adjacent controls.
$\frac{1}{4}$ acre.									
1	Cut in	October	and	dug in	at	once	...	1,876	
2	"	"	March	"	"	"	"	2,012	—
3	"	"	October	"	"	"	"	2,148	
4	"	"	March	"	"	"	"	2,119	— 3
5	"	"	October	"	"	"	"	2,096	
6	"	"	March	"	"	"	"	1,858	— 238
7	"	"	October	"	"	"	"	2,096	
8	"	"	March	"	"	"	"	1,788	— 189
9	"	"	October	"	"	"	"	1,858	
10	"	"	March	"	"	"	"	1,871	— 59
11	"	"	October	"	"	"	"	2,002	
12	"	"	March	"	"	"	"	1,758	— 178
13	"	"	October	"	"	"	"	1,870	
14	"	"	March	"	"	"	"	1,708	— 205
15	"	"	October	"	"	"	"	1,956	
16	"	"	March	"	"	"	"	1,814	— 95
17	"	"	October	"	"	"	"	1,863	
Average								1,974	— 121

Average yield of 9 control plots dug in at the beginning of dry season, 1928. 1,974 lb
 „ difference of 8 plots dug in at the end of „ „ March, 1929.
 — 121 $\pm$ 54.

Variety—Lagos White.

Sown 26th March, 1929. Supplied 9th April. Singled 29th April and 7th May.
 Ridged 31st October, 1929 and 7th March, 1930. Weeded 13th December, 1929,
 13th March, 8th April, 20th April, 16th May.

Stumped November 1st, Cutting trace November 23rd.

Mucuna planted 30th May and weeded June 13th and July 4th.

Cost in man-days per acre = 89.

TABLE No. 3.
TREATMENT OF COVER CROP EXPERIMENT, 1929.
(5 acres).

Plot.	Treatment.	Crop.	Yield in lb. per acre.	Increase (+) or Decrease (-) compared with mean of adjacent controls.
C5N. ($\frac{1}{4}$ acre.)				
A. 1	Cover cut in February and dug in at once	Maize	(1,415)	
2	Cover burnt in February then dug	"	1,623	
3	Cover burnt in February then moulded	"	1,485	- 223
4	Cover burnt in February then dug	"	1,793	
5	Cover burnt in February then moulded	"	1,565	- 211
6	Cover burnt in February then dug	"	1,760	
7	Cover burnt in February then moulded	"	1,494	- 274
8	Cover burnt in February then dug	"	1,776	
9	Cover burnt in February then moulded	"	1,557	- 207
10	Cover burnt in February then dug	"	1,753	
	Average		1,741	- 229
B. 11	Cover cut in November and odd plots dug in at once	Maize	1,969	
12	Cover cut in November and even plots left to rot and dug in in February	"	1,798	- 166
13	Cover cut in November and dug in at once	"	1,959	
14	Cover cut in November left to rot and dug in in February... ..	"	1,733	- 294
15	Cover cut in November and dug in at once	"	2,095	
16	Cover cut in November left to rot and dug in in February	"	1,780	- 78
17	Cover cut in November and dug in at once	"	1,621	
18	Cover cut in November left to rot and dug in in February... ..	"	1,733	- 42
19	Cover cut in November and dug in at once	"	1,930	
20	Cover burnt in February and dug in at once	"	(1,699)	
	Average		1,914	- 145

Average yield of 5 plots burnt in February and dug in 1,741.

" difference of 4 plots burnt in February moulded up - 229 $\pm$ 44.

" yield of 5 plots cut in November and dug in at once ... 1,914.

" " " 4 " " " " " in March ... -145 $\pm$ 145.

Variety—Lagos White.

Ridged October 30th, February 26th and 27th (moulding 27th). Sown 27th March, 1929.
Supplied 9th April. Thinned 29th April and 7th May. Weeded December 13th, February
2nd, March 13th, April 8th, 10th, 19th and May 15th (Mucuna planted May 30th and
weeded June 13th and July 5th).

Cost in man-days per acre = 83.

TABLE No. 4.
B3E.—LATE MAIZE.
GREEN MANURE EXPERIMENT.
 $3\frac{1}{4}$ acres.

Plot.	Acre.	Variety and Treatment.	Yield per acre. lb.	Increase (+) or decrease (-) compared with mean of adjacent control.
1	$\frac{1}{4}$	Mucuna	1,304	-193
2	"	Dolichos	1,091	
3	"	Mucuna	1,264	-237
4	"	Lima	1,091	
5	"	Mucuna	1,392	-62
6	"	Calopogonium ...	1,382	
7	"	Mucuna	1,497	-63
8	"	Dolichos	1,544	
9	"	Mucuna	1,718	-495
10	"	Lima	1,317	
11	"	Mucuna	1,907	-100
12	"	Calopogonium ...	1,701	
13	"	Mucuna	1,696	

Average yield of 7 plots with Mucuna	...	...	=	1,540 lb.	Odds.
" difference of 2 plots with Dolichos	...		=	- 128±114	6 : 1
" " 2 " " Lima	...	...	=	- 366±114	1,500 : 1
" " 2 " " Calopogonium			=	- 81±114	3 : 1

Planted—9th September, 1929.

Supplied—17th " "

Harvested—6th January, 1930.

Cost in man-days per acre = 115.

TABLE No. 5.
 MOULDING *versus* RIDGING.
 D5N.—GROUNDNUTS. (NATIVE ZARIA.)

5 acres.

Plot,	Treatment.			Yield per acre. lb.		Increase (+) or decrease (−) compared with mean of adjacent controls.
1	Ridged	...	...	1,488		
2		Moulded	...		1,462	+ 62
3	Ridged	...	...	1,311		
4		Moulded	...		1,516	+174
5	Ridged	...	...	1,372		
6		Moulded	...		1,255	− 83
7	Ridged	...	...	1,305		
8		Moulded	...		1,537	+318
9	Ridged	...	...	1,132		
10		Moulded	..		1,521	+203
11	Ridged	...	...	1,504		
12		Moulded	...		1,277	−203
13	Ridged	...	...	1,456		
14		Moulded	...		1,430	− 84
15	Ridged	...	...	1,573		
16		Moulded	...		1,440	−131
17	Ridged	...	...	1,569		
18		Moulded	...		1,307	−206
19	Ridged	...	...	1,458		
20		(N.E.)	...	(1,189)		

Average of 10 controls (Ridged) = 1,417 lb. per acre.

Average difference of 9 treatments (Moulded) = $+5.5 \pm 54$ (insignificant).

Sown :—12th March, 1929. Supplied 16th April and 13th May, 1929.

Ridged :—March 5th and 6th, Moulding 6th. Weeded April 11th and 23rd, May 3rd, 8th, 22nd, June 5th, clearing dub 12th June. Handweeding 28th June, weeding July 11th, August 19th, roguing rosetted plants June 26th.

Cost in man-days per acre of ridged plots = 123.

" " " " " " " moulded plots = 114.

TABLE No. 6.

D6S. GROUNDNUTS.

ACCLIMATISATION TEST (NEWLY GROWN ZARIA
versus ONCE GROWN ZARIA.)

(5 acres.)

Plot.	Treatment.	Yield per acre. lb.	Increase (+) or decrease (—) com- pared with mean of adjacent controls.
21	Acclimatized	1,207	
22	Newly Imported Zaria	1,461	+150
23	Acclimatized	1,414	
24	Newly Imported Zaria	1,349	+ 29
25	Acclimatized	1,225	
26	Newly Imported Zaria	1,242	— 32
27	Acclimatized	1,324	
28	Newly Imported Zaria	1,302	— 17
29	Acclimatized	1,314	
30	Newly Imported Zaria	1,189	— 169
31	Acclimatized	1,402	
32	Newly Imported Zaria	1,260	— 189
33	Acclimatized	1,497	
34	Newly Imported Zaria	1,374	— 116
35	Acclimatized	1,484	
36	Newly Imported Zaria	1,447	— 48
37	Acclimatized	1,507	
38	Newly Imported Zaria	1,364	— 49
39	Acclimatized	1,320	
40	Acclimatized	(1,260)	

Average yield of 10 controls = 1,370 lb. Odds.

„ difference of 9 Zaria = —50 ± 41 7 : 1

Sown 13th March, 1929. Supplied 16th and 17th April, 14th May.

Moulded March 6th. Handweeded April 11th, weeded April 23rd.

Clearing Dhub June 4th and 12th. Handweeded May 2nd, weeded May 8th.

Handweeded June 29th, weeded July 11th. Rogueing rosetted plants June 26th, August 19th.

Cost in man-days per acre = 119.

TABLE No. 7.
A7S. YAMS.
TIME OF PLANTING TEST.
(5 acres.)

Plot.	Acre.	Treatment.	Variety.	Yield per acre lb.		Increase (+) or decrease (−) compared with mean of adjacent controls.
21	$\frac{1}{4}$	Planted 23/11/28 ...	Iyawo	6,796	1,940	−4,682
22	"	" 31/12/28 ...	"	6,448	5,214	−1,458
23	"	" 23/11/28 ...	"	6,896	3,176	−3,538
24	"	" 8/2/29 ...	"	6,532	5,738	−1,284
25	"	" 23/11/28 ...	"	7,512	3,216	−4,371
26	"	" 31/12/28 ...	"	7,662	6,424	− 832
27	"	" 23/11/28 ...	"	6,850	2,444	−4,460
28	"	" 8/2/29 ...	"	6,958	4,338	−1,924
29	"	" 23/11/28 ...	"	5,566	1,792	−3,639
30	"	" 31/12/28 ...	"	5,296	3,010	Non-experimental.
31	"	" 23/11/28 ...	"			
32	"	" 8/2/29 ...	"			
33	"	" 23/11/28 ...	"			
34	"	" 31/12/28 ...	"			
35	"	" 23/11/28 ...	"			
36	"	" 8/2/29 ...	"			
37	"	" 23/11/28 ...	"			
38	"	" 31/12/28 ...	"			
39	"	" 23/11/28 ...	"			
40	"	" 8/2/29 ...	"			

Average yield of 10 control plots 6,652 lb.

" difference of 5 plots sown December 31st, 1928 $-4,138 \pm 302$

Odds that this difference is significant $\infty : 1$

Average difference of 4 plots sown on February 8th, 1929 $-1,374 \pm 338$

Odds that this difference is significant 33,300 : 1

Ridged October 10th-12th. Planted 23rd November, 1928. Marking 30th December, 1928. Planting December 31st. Planting 8th February. Mulched 7th and 8th December and 31st, January 2nd. Covering January 4th, February 9th. Weeded November 12th, 13th; December 20th, January 29th-31st; March 9th, 11th; April 11th, 12th, 30th; May 20th, June 8th. Staking March 8th, 23rd; April 8th; May 8th, 10th and 27th; June 12th, 25th and July 15th.

Cost in man-days per acre = 169.

TABLE No. 8.
Z5N & S—YAMS
(10 acres.)

Plot.	Acre.	Variety and Treatment.			Yield per acre lb.	Increase (+) or decrease (—) com- pared with ad- jacent controls.
1	$\frac{1}{4}$	Iyawo	...	...	5,508	
2	"	Esinmerin	...	...	8,808	+ 3,347
3	"	Iyawo	...	...	5,414	
4	"	Odo	...	...	5,940	+ 259
5	"	Iyawo	...	...	5,948	
6	"	Alade	...	...	6,548	+ 15
7	"	Iyawo	...	...	7,118	
8	"	Esinmerin	...	...	11,956	+ 4,637
9	"	Iyawo	...	...	7,520	
10	"	Odo	...	...	6,632	— 841
11	"	Iyawo	...	...	7,426	
12	"	Alade	...	...	6,978	+ 240
13	"	Iyawo	...	...	6,050	
14	"	Esinmerin	...	...	9,920	+ 3,725
15	"	Iyawo	...	...	6,340	
16	"	Odo	...	...	5,786	— 97
17	"	Iyawo	...	...	5,426	
18	"	Alade	...	...	5,968	+ 663
19	"	Iyawo	...	...	5,184	
20	"	A g a k e (non-experimental)			(5,886)	(+ 108)
21	"	Iyawo	...	...	6,372	
22	"	Esinmerin	...	...	10,332	+ 3,644
23	"	Iyawo	...	...	6,964	
24	"	Odo	...	...	5,746	— 1,123
25	"	Iyawo	...	...	6,774	
26	"	Alade	...	...	7,284	+ 47
27	"	Iyawo	...	...	7,700	
28	"	Esinmerin	...	...	13,424	+ 5,788
29	"	Iyawo	...	...	7,572	
30	"	Odo	...	...	8,898	+ 1,195
31	"	Iyawo	...	...	7,834	
32	"	Alade	...	...	7,384	+ 57
33	"	Iyawo	...	...	6,820	
34	"	Esinmerin	...	...	10,758	+ 3,590
35	"	Iyawo	...	...	7,516	
36	"	Odo	...	...	7,226	+ 133
37	"	Iyawo	...	...	6,670	
38	"	Alade	...	...	7,802	+ 1,173
39	"	Iyawo	...	...	6,588	
40	"	A g a k e (non-experimental)			7,844	

Average yield of 20 controls = 6,637 lb. per acre.
(Z5N. = 6,193; Z5S = 7,081)

TABLE No. 8—continued.

Average difference of *Esinmerin* (6) = + 4,122 $\pm$ 291. Odds that this is significant = ∞ . Average difference of *Odo* (6) = - 79 $\pm$ 291; Entirely in significant. Average difference of *Alade* (6) = + 366 $\pm$ 291 Odds that this is significant = 8 : 1

Average yield Iyawo 6,637 lb. per acre. Esinmerin 10,866 lb. per acre.

„ „ Odo 6,704 „ „ „ Alade 6,994 „ „ „

Ridged, October 19th to 24th. Planted 19th and 21st November. Mulched November 21st, 28th-30th, December 1st, 3rd-5th, January 22nd, and February 9th. Weeded December 19th, 20th, January 2nd and 4th, March 8th, April 8th-10th, May 1st 21st, June 11th, 12th, July 4th, August 6th and 7th.

Staking February 13th, 14th, 20th, March 8th, 16th, April 5th, May 10th, 15th, 27th, June 17th, July 8th, 23rd.

Cost in man-days per acre = 181.

TABLE No. 9.

COCONUTS, 1929.

Plot.	Area.	Planting Distance.	NO. OF TREES AT END OF YEAR.			Vacancies.	No. of collections.	Total yield of nuts.
			Bearing.	Non-bearing.	Young Plants.			
B1	5	30' $\times$ 30'	181	9	2	50	5	8,040
C1	5	25' $\times$ 25'	228	51	10	49	5	5,452

TABLE No. 10.

COCOA YIELDS, 1929.

Plot.	Acreage.	Variety.	Planted.	YIELD PER ACRE LB.	
				Wet Beans.	Dry Beans.
A1	...	2.5	Yellow pod ...	2,126.	} 632
Y1	...	4.75	Red pod ...	861.	

TABLE No. 11.

KOLA (GBANJA), 1929.

2½ acres. Planted 15' $\times$ 15' in 1913.

Plot.	No. of collections.	No. of pods.	Weight of pods lb.	No. of Nuts, good or bad.	Weight of good nuts lb.	Yield of nuts in lb per acre.
Y5	27	4,168	2,450	20,506	817	326.8
Y2	3	77	28	377	7	—

TABLE No. 12.

COFFEE, 1929.

PLANTED 12' × 12' IN 1925.

Plot.	Variety.	Area.	Yield of fresh berries per plot in lb.	Yield of parchment Coffee per plot in lb.	Yield of parchment Coffee in lb. per acre.
A2, S.E.	Abeokuta	1 acre	564	133	133

TABLE No. 13.

PALM TAPPING, 1929.

No. of trees.	No. of periods.	Total No. of days in the periods.	Yield of wine.	Yield of wine 1917-1929 in gallons.	REMARKS.
7	8	81	4,773 in c/c	122·3	—
9	6	61	1,470 „ „	38·2	—
10	12	150	9,943 „ „	78·1	—

TABLE No. 14.

COST OF CULTIVATION OF MAIN CROPS—1929.

Figures in man-days per acre, obtained from plots of the Main Rotation.

Z5, N. and S; A6S; B4W; D5N; D6S; Z7, N. and S.

Crop.	Preparation.	Establishing.	After cultivation.	Harvesting.	Store work.	Total.
Yams (Z5)	47	55	49	25	18	194
Green Manure and	2·3	3·6	26	—	—	31·9
Cotton A6S, B4W	32·0	6·5	24	38	—	100·5
Groundnuts & Cover	10	18	39	54	14	135
Crops, D5N, D6S	—	3·6	10·8	9	—	23·4
Maize and Cover	28	9	12	11	3·5	63·5
Crop, Z7, (N. and S.)	2·7	1·7	9·4	—	—	13·8

TABLE No. 15.

COMPARISON OF COST OF PRODUCTION OF REVENUE FOR MAIN ROTATION.
CROPS, 1929-30 SEASON. MOOR PLANTATION.

Average Cost of labour for year 1s. 1d. per man-day.

Crops.	Cost of crops in man-days per acre.	Average yield in lb. per acre.	Cost of production in man-day per acre.	Market value per lb. at store.	Calculated return per man-day.	Gross Monetary return per man-day.	Nett Monetary return per man-day.	Kind of crops.
Yams, Gross	194	7,346	·026	·428d.	£ 13 2 0	16·2d.	+ 3·2d.	Good tubers.
" Nett	174	4,033	·048	·428d.	7 3 10	8·9d.	- 4·1d.	" "
Botanist Cotton, Ishan	100·5	405	·27	2·25d.	3 15 11	9·1d.	- 3·9d.	Seed cotton.
Groundnuts	135	1,376	·098	·296d.	2 9 2	9·3d.	- 4·7d.	Uncorticated.
Early Maize	63·5	1,995	·032	·388d.	3 3 8	12·3d.	- 3·7d.	Dry grain (excludes cobs sold).

ANNUAL REPORT, OGBA PLANTATION, BENIN, 1929.

The following officers were in charge of the station during the year :—

Mr. O. J. Voelcker, from 1st January to 7th April.

„ G. W. G. Briggs, from 8th April to 20th November.

„ J. L. B. Kincaid, from 21st November to 31st December.

Experiments have been carried on during the year 1929 on lines similar to former years. The rains were late, the rainfall during March was much below average, but the total fall for the year was considerably above the average for the previous six years. Several of the cover crops, which had been planted during February were considerably retarded owing to the lack of rain in March.

COVER CROP EXPERIMENTS.

(a) Time of cutting cover crop experiment 1929. Table No. 1.

	Yield of maize in lb. dry grain per acre.	Odds that difference is significant.
Average yield of 5 plots with Mucuna dug in during November	458	—
Average difference of 4 plots with Mucuna dug in during February ...	+ 175±115	14 : 1

This experiment is similar to that carried out in 1928. The yields of Maize are poor throughout and the results are not so significant. The inferiority of the plots in which the cover crop is dug in during November is probably due partly to the effect of sowing the maize on stale ridges, and partly to losses from the leguminous material during the intervening months between digging in and sowing of the maize crop.

(b) Mucuna once sown *versus* twice sown. Early maize test crop, 1929. Table No. 2.

	Yield of maize in lb. dry grain per acre.	Odds that difference is significant.
Average yield of 5 plots following Mucuna once sown	845	—
Average difference of 4 plots following Mucuna twice sown	— 231±48	over 33,300 : 1

This experiment is a repetition of the 1927 test to compare the effect of *Mucuna* sown at the commencement of the rains and left till the following year, with *Mucuna* sown at the commencement of the rains, dug in at its greatest bulk in July, and resown and left till the following year. The *Mucuna* was dug in on the same date in all plots, and the early maize test crop was sown in the dry ground at the beginning of March. It is probable that the lower yields following *Mucuna* twice sown were due to losses by leaching during the period when the land was lying bare, *i.e.* after the digging in of the first crop of *Mucuna*, until the second sowing of *Mucuna* had formed a satisfactory cover.

MAIZE EXPERIMENTS.

(a) Early Maize manurial experiment 1929. Table No. 3.

T41-45.

	Yield of maize in lb. dry grain per acre.	Odds that difference is significant.
Average yield of 3 unmanured plots ...	762	—
Average difference of 2 plots manured with cyanamide	+118±256	2 : 1

Y49-54.

Average yield of 3 unmanured plots ...	549	—
Average difference of 2 plots manured with cyanamide	+112±11	over 33,000 : 1

This experiment follows on the late maize manurial trial of 1928, as owing to the late sowing date of the former trial the crop was poor and the results unsatisfactory. No fresh application of cyanamide being made, the residual effect of the 3 cwt. per acre dressing applied on the 4th October, 1928, was to be ascertained. Block Y49-54 gave lower yields than block T41 49 but the results appear to be more significant on the slightly better soil. The increased yields of maize at 6s. 6d. per cwt. dry grain are not, however, commensurate with the cost of the 3 cwt. per acre dressing of cyanamide at a cost of approximately £2 per acre.

(b) Early Maize.—One plant per stand *versus* two plants per stand. Table No. 4.

	Yield of maize in lb. dry grain per acre.	Odds that difference is significant.
Average yield of 5 plots with one plant per stand	619	—
Average difference of 4 plots with two plants per stand	+81±130	3 : 1

There appears from this result to be little advantage in leaving two plants to each stand of maize. Probably the land has as much as it can carry when the normal practice of growing one maize plant at a stand at Benin is maintained.

(c) Early Maize—Time of planting experiment. Table No. 5.

	Yield of maize in lb. dry grain per acre.	Odds that difference is significant.
Average yield of 8 plots sown 25th March	665	—
Average difference of 4 plots sown 9th April	-202 ± 65	800 : 1
Average difference of 3 plots sown 22nd April	-387 ± 75	over 33,000 : 1

The results are very definitely in favour of early planting of maize at Benin.

(d) Early Maize—Density of palms experiment. Table No. 6.

	Yield of maize in lb. dry grain per acre.	Odds that difference is significant.
Average yield of 3 plots without palms	621	—
Average difference of 1 plot with 21 palms per acre	-160 ± 32	over 33,300 : 1
Average difference of 1 plot with 33 palms per acre	-120 ± 32	5,000 : 1

(e) Late Maize—Density of palms experiment. Table No. 7.

	Yield of maize in lb. dry grain per acre.	Odds that difference is significant.
Average yield of 3 plots without palms	518	—
Average difference of 1 plot with 21 palms per acre	-172 ± 113	14 : 1
Average difference of 1 plot with 33 palms per acre	-124 ± 113	6 : 1

In both this and the preceding experiment the palms are young, and their effect is still small.

YAM EXPERIMENT.

Yam cultivation experiment 1929. Table No. 8.

This experiment is a continuation of the 1928 cultivation trial on late maize. *Mucuna* was sown in all plots on 16th February and formed a cover till May, when the experiment recommenced.

(1) On nine control plots the *Mucuna* was ridged in and yams planted. These plots received no further cultivation except hand-weeding when necessary, thus receiving partial cultivation only.

(2) On four experimental plots the *Mucuna* was cut back and the cut tops left in the furrows. These plots were not ridged, but received a hand-weeding only before being planted with yams, and hand-weeding when necessary. These plots thus received no cultivation.

(3) On four experimental plots the *Mucuna* was ridged in and yams planted. These plots received surface cultivation with hoes twice weekly during growth, after 1st July, and thus received thorough cultivation.

	Nett yield of yams in lb. per acre.	Odds that difference is significant.
Average yield of 9 plots ridged and hand- weeded	2,640	—
Average difference of 4 plots not ridged but handweeded	—930±268	4,350 : 1
Average difference of 4 plots ridged and hoed twice weekly	—318±268	8 : 1

Costs of cultivation under the various treatments, per acre.

	Partial Cultivation.	No Cultivation.	Thorough Cultivation.
Ridging	18	—	18
Establishing	10	10	10
After cultivation... ..	50	50	73
Harvesting	28	28	28
	106 man-days	88 man-days	129 man-days.
Total Cost	£4 17s. 2d.	£4 0s. 8d.	£5 18s. 3d.

Taking the local price of yams at 480d. per lb., the returns from each of the treatments are, per acre :

		£	s.	d.
Partially cultivated plots	2,640 lb. =	5	5	7
Uncultivated plots	1,710 „ =	3	8	4
Thoroughly cultivated plots	2,322 „ =	4	12	10

The partially cultivated plots as compared with the uncultivated plots thus cost 16s. 6d. more per acre, while the increased return amounts to £1 17s. 3d. The thoroughly cultivated plots cost £1 1s. 1d. more per acre than the partially cultivated plots and the return is 12s. 9d. less.

TABLE No. 1.

COVER CROP—TIME OF CUTTING EXPERIMENT, 1929.

Plot.	Treatment.	Crop.	Yield of dry grain lb. per acre.	Increase (+) or de- crease (—) compared with mean of adjacent controls.
Z71	Dug in end of November	Early Maize	486	
72	Dug in end of February	„	838	+ 279
73	Dug in end of November	„	633	
74	Dug in end of February	„	657	+ 134
75	Dug in end of November	„	412	
76	Dug in end of February	„	577	+ 94
77	Dug in end of November	„	554	
78	Dug in end of February	„	571	+ 192
79	Dug in end of November	„	205	
	Average	...	458	+ 175

TABLE No. 1—*continued*.

Each plot $\frac{1}{4}$ acre—Sown March 22nd—supplied April 3rd, 16th and 30th—singled April 17th—harvested July 25th, August 16th.

Root—mean—square—difference between neighbouring control plots = 230 lb. per acre.

Average yield of 5 plots dug in end of November ... 458 lb. per acre.

Average difference of 4 plots dug in end of February ... +175 $\pm$ 115

Ridged—control plots 22nd November, 1928. 6 feet ridges, 2 rows maize experimental plots 28th February, 1929, per ridge, stands 18 inches apart, staggered, one plant per stand.

Weeded April 25th, June 19th, July 15th.

Cost of cultivation 47 man-days per acre.

TABLE No. 2.

MUCUNA ONCE SOWN *versus* TWICE SOWN EXPERIMENT, 1929.

Plot.	Treatment.	Crop.	Yield of dry grain in lb. per acre.	Increase (+) or decrease (–) compared with mean of adjacent controls.
Y31	Mucuna once sown	Early Maize	735	
32	Mucuna twice sown	„	598	– 147
33	Mucuna once sown	„	755	
34	Mucuna twice sown	„	570	– 279
35	Mucuna once sown	„	942	
36	Mucuna twice sown	„	755	– 166
37	Mucuna once sown	„	900	
38	Mucuna twice sown	„	562	– 334
39	Mucuna once sown	„	892	
Average			845	– 231 $\pm$ 48

Each plot $\frac{1}{4}$ acre.—Sown 6th March—supplied 2nd, 16th and 29th April—singled 19th April and 28th May—harvested 24th July and 13th August.

Root—mean—square—difference between neighbouring control plots = 96 lb. per acre.

Average yield of 5 plots with Mucuna once sown ... 845 lb. per acre.

Average difference of 4 plots with Mucuna twice sown ... – 231 $\pm$ 48

Ridged 20th February—6 feet ridges, maize 2 rows per ridge, stands 18 inches apart, one plant per stand.

Weeded 30th April, 15th June and 10th July.

Cost of cultivation 62 man-days per acre.

TABLE No. 3.

EARLY MAIZE MANURIAL EXPERIMENT, 1929.

Plot.	Treatment.			Crop.	Yield of dry grain lb. per acre.	Increase (+) or decrease (—) compared with mean of adjacent controls.
T41	No Manure	...	...	Early Maize	873	
42	Cyanamide	...	...	"	1,054	+ 138
43	No Manure	...	...	"	958	
44	Cyanamide	...	...	"	805	+ 98
45	No Manure	...	...	"	455	
Average					762	+ 118 $\pm$ 256

Root—mean—square—difference between neighbouring controls = 362 lb. per acre.

Average yield of 3 plots unmanured 762 lb. per acre.

Average difference of 2 plots manured with cyanamide ... + 118 $\pm$ 256

Y49	Non-Experimental	...	...	Early Maize	669	
50	No Manure	...	...	"	533	
51	Cyanamide	...	...	"	604	+ 61
52	No Manure	...	...	"	552	
53	Cyanamide	...	...	"	721	+ 163
54	No Manure	...	...	"	563	
Average					549	+ 112 $\pm$ 11

Root—mean—square—difference between neighbouring controls 15 lb. per acre.

Average yield of 3 plots unmanured 549 lb. per acre.

Average difference of 2 plots manured with cyanamide + 112 $\pm$ 11

Each plot $\frac{1}{4}$ acre—sown 21st March—supplied 3rd and 29th April—singled 18th March, 21st May—harvested 22nd July and 12th August, 1929.

Ridged 9th March—6 feet ridges, 2 rows maize per ridge, stands 18 inches apart, staggered, 1 plant per stand.

Weeded 30th March, 22nd June.

Cost of cultivation of above experiment = 58 man-days per acre.

TABLE No. 4.

EARLY MAIZE—ONE PLANT PER STAND *versus* TWO PLANTS
PER STAND.

Plot.	Treatment.	Crop.	Yield of dry grain (lb. per acre).		Increase (+) or decrease (−) compared with mean of adjacent controls.
W 21	One plant per stand	Early Maize	808		
22	Two plants „ „ ...	„ „	846		+ 60
23	One plant „ „ ...	„ „	765		
24	Two plants „ „ ...	„ „	674		+108
25	One plant „ „ ...	„ „	368		
26	Two plants „ „ ...	„ „	451		− 63
27	One plant „ „ ...	„ „	660		
28	Two plants „ „ ...	„ „	798		+ 221
29	One plant „ „ ...	„ „	495		
Average			619		+81±130

Root—mean—square—difference between neighbouring control plots = 261.

Sown March 28th—supplied April 8th, April 15th—thinned April 27th—
harvested July 24th.

Average yield of 5 plots with one plant per stand = 619

Average difference of 4 plots with two plants per stand = +81±130

Ridged March 2nd—6 feet ridges, two rows per ridge, stands 18 inches apart.

Weeded May 2nd, June 5th, July 15th.

Cost of cultivation = 68 man-days per acre.

TABLE No. 5.

MAIZE—TIME OF PLANTING EXPERIMENT, 1929.

Plot.	Treatment.	Crop.	Yield of dry grain lb. per acre.	Increase (+) or decrease (—) compared with mean of adjacent controls.
W 30	Sown 25th March ...	Early Maize	776	
31	" 9th April ...	" "	544	— 155
32	" 25th March ...	" "	623	
33	" 22nd April ...	" "	277	— 383
34	" 25th March ...	" "	697	
35	" 9th April ...	" "	524	— 169
36	" 25th March ...	" "	689	
37	" 22nd April ...	" "	294	— 341
38	" 25th March ...	" "	582	
39	" 9th April ...	" "	512	— 100
40	" 25th March ...	" "	642	
41	" 22nd April ...	" "	271	— 437
42	" 25th March ...	" "	774	
43	" 9th April ...	" "	271	— 385
44	" 25th March ...	" "	538	
Average			665	

Root—mean—square—difference between neighbouring control plots
130 lb. per acre.

Each plot $\frac{1}{4}$ acre—Sown 25th March, 9th April, 22nd April—supplied 15th April,
22nd April—thinned 20th April, 28th May—harvested 24th
July.

Average of 8 plots planted 25th March... .. 665
 „ difference of 4 plots planted 9th April —202±65
 „ „ „ 3 „ „ 22nd „ —387±75

Ridged 5th March—6 feet ridges, 2 rows per ridge, stands 18 inches apart staggered,
one plant per stand.

Weeded 14th May, 17th June, 11th July.

Cost of cultivation of above experiment = 55 man-days per acre.

TABLE No. 6.

MAIZE—DENSITY OF PALMS EXPERIMENT.

Plot.	Treatment.				Crop.	Weight of dry grain lb. per acre.		Increase (+) or decrease (−) compared with mean of adjacent controls.
Q 1	Nil	palms	...	...	Early Maize.	656		
2	33	"	...	...	" "	519		− 120
3	Nil	"	...	...	" "	622		
4	21	"	...	...	" "	477		− 160
5	Nil	"	...	...	" "	652		
Average						643		

Root—mean—square—difference between neighbouring control plots = 32.

1 acre plots—sown 29th March—supplied 6th, 15th April—thinned 19th April,
21st, 28th May.

Harvested 25th July.

Average of 3 control plots without palms = 621 lb.

Average difference of 1 plot with 33 palms per acre = − 120±32

Average difference of 1 plot with 21 palms per acre = − 160±32

Ridged 9th February, 6 feet ridges, 2 rows per ridge, stands 18 inches apart.

Weeded—24th April, June 25th, July 19th.

Cost of cultivation = 80 man-days per acre.

TABLE No. 7.

LATE MAIZE—DENSITY OF PALMS EXPERIMENT.

Plot.	Treatment.			Crop.	Weight of dry grain lb. per acre.		Increase (+) or decrease (-) compared with mean of adjacent controls
P1	Nil palms	...	...	Late Maize	422		
2	33 palms ...	...	...	"	328		- 172
3	Nil palms	...	...	"	579		
4	21 palms ...	...	...	"	441		- 124
5	Nil palms	...	...	"	552		
Average				...	518		

Root—mean—square—difference between neighbouring control plots = 113

1 acre plots—sown 3rd September—supplied 13th and 28th September—thinned 20th September, 6th and 17th October—harvested 30th December, 1929.

Average of 3 control plots without palms 518

Average difference of 1 plot with 33 palms per acre... .. -172 $\pm$ 113

Average difference of 1 plot with 21 palms per acre... .. -124 $\pm$ 113

Ridged 22nd August, 1929—6 feet ridges, 2 rows per ridge, stands 18 inches apart, staggered, one plant per stand.

Weeded 12th November, 1929.

Cost of cultivation 49 man-days per acre.

TABLE NO. 8.
YAM CULTIVATION EXPERIMENT, 1929.

Plot.	Treatment.	Crop.	Nett yield of tubers in lb. per acre.	Increase (+) or decrease (—) compared with mean of adjacent controls.
T21	Partial Cultivation ...	Yams	3,144	
22	No Cultivation ...	"	1,576	— 1,302
23	Partial Cultivation ...	"	2,612	
24	Thorough Cultivation ...	"	2,128	— 180
25	Partial Cultivation ...	"	2,004	
26	No Cultivation ...	"	1,708	— 692
27	Partial Cultivation ...	"	2,796	
28	Thorough Cultivation ...	"	2,152	— 608
29	Partial Cultivation ...	"	2,724	
30	No Cultivation ...	"	2,252	— 740
31	Partial Cultivation ...	"	3,260	
32	Thorough Cultivation ...	"	2,988	+ 154
33	Partial Cultivation ...	"	2,404	
34	No Cultivation ...	"	1,440	— 986
35	Partial Cultivation ...	"	2,444	
36	Thorough Cultivation ...	"	1,768	— 638
37	Partial Cultivation ...	"	2,368	
Average ...			2,640	

Each plot 1/5 acre—Yams planted 21st May—staked 18th June—harvested 21st November, 19th December and 28th February.

Planting rate 704 yams per plot. 6 feet ridges.

Root—mean—square—difference between neighbouring control plots 537 lb. per acre.

Average yield of 9 plots partially cultivated ... 2,640

Average difference of 4 plots uncultivated ... —930 ± 268

Average difference of 4 plots thoroughly cultivated ... —318 ± 268

Partially cultivated plots: Ridged and Mucuna dug in 15th May. Hand-weeded 12th June, 22nd July, 5th September, 25th October.

Uncultivated plots: Mucuna cut back 15th May. Handweeded 12th June, 22nd July, 5th September, 25th October.

Thoroughly cultivated plots: Ridged and Mucuna dug in 15th May. Hand-hoed twice weekly after 1st July.

TABLE No. 9.
ANNUAL CROP YIELDS: BENIN, 1929.

Crop.	Block.	Area in acres.	Average yield (all plots) lb. per acre.	Condition of crop.
<i>Early Maize.</i>				
1. 3 Year Rotation ...	W30-46	4 $\frac{1}{4}$	490	Dry grain.
2. Native Farming <i>versus</i> Continuous Cropping. Continuously Cropped plots only. (a) Stumped	W97-113			
(b) Unstumped.		1	1,216	" "
3. Manurial Experiment	Y49-54	1 $\frac{1}{2}$	958	" "
	T41-45	1	607	" "
			829	" "
4. Cassava Exhaustion Experiment	Y22-30	2 $\frac{1}{4}$	515	" "
5. One plant per stand <i>versus</i> two per stand Experiment ...	W21-29	2 $\frac{1}{4}$	652	" "
6. Mucuna once sown <i>versus</i> twice sown Experiment ...	Y31-39	2 $\frac{1}{4}$	745	" "
7. Cover Crop—Time of Cutting Experiment ...	Z71-79	2 $\frac{1}{4}$	546	" "
8. Density of Palms Experiment	Q1-5	5	585	" "
<i>Late Maize.</i>				
1. Density of Palms Experiment	P1-5	5	464	" "
<i>Yams.</i>				
1. Native Farming <i>versus</i> Continuous Cropping. Continuously Cropped plots only.	W80-96			Nett yield.
(a) Stumped		1	446	
(b) Unstumped		1	906	
2. 3 Year Rotation ...	Z29-45	4 $\frac{1}{4}$	2,050	" "
3. Cultivation Experiment	T21-40	4	2,340	" "

TABLE No. 10.

COMPARISON OF CROP YIELDS, BENIN, 1925-29.

Experiment.	Block.	1925.	1926.	1927.	1928.	1929.
Palm intercropping ...	M1-5	2,928 yams	...	...	9,976 yams	Maize (failure)
Density of palms ...	P1-5	...	4,205 yams	503 L.M.	..	464 L.M.
" " " ...	Q1-5	...	...	4,769 yams	...	585 E.M.
Maize—One <i>versus</i> two plants per stand ...	W21-29	...	...	612 E.M.	...	652 E.M.
3-year Rotation ...	W30-46	...	9,109 yams	...	8,656 yams	490 E.M.
" " " ...	Y3-21	1,726 E.M.	8,709 yams	...	1,396 E.M.	...
" " " ...	Z29-45	...	910 E.M.	1,621 yams	...	2,050 yams (nett)
Cassava Exhaustion ...	Y22-30	1,515 E.M.	...	7,609 yams	...	515 E.M.
Mucuna—Once <i>versus</i> twice sown ...	Y31-39	1,127 E.M.	...	1,062 E.M. 470 L.M.	...	745 E.M. ...
Cover Crop Burning ...	Y40-48	...	...	313 E.M.	819 E.M.	...
Cyanamide Manurial Test ...	Y49-54	...	...	...	82 L.M.	607 E.M.
Cyanamide Manurial Test ...	T41-45	...	...	...	128 L.M.	829 E.M.
Green Manuring Trial ...	Z46-70	7,169 yams	...	619 L.M.	...	...
Cover Crop—Time of cut- ting ...	Z71-79	...	7,324 yams	...	1,199 E.M.	546 E.M.
Native Farming <i>versus</i> Continuous Cropping	Y80-96	6,433 yams	...	Failure	7,729 yams	...
Native Farming <i>versus</i> Continuous Cropping	W80-96	...	8,847 yams	...	1,072 E.M.	676 yams (nett)
Native Farming <i>versus</i> Continuous Cropping	W97-113	...	...	6,450 yams	...	1,087 E.M.
Cultivation Test ...	T21-40	...	...	...	331 E.M.	2,340 yams (nett)

E.M. = Early Maize. L.M. = Late Maize.

Yam yields gross 1925-1928, 1929 yields nett.

TABLE No. 11.

COST OF CULTIVATION OF MAIN ANNUAL CROPS.

Figures in man-days per acre (average of all plots).

Crop.	Preparation.	Establish- ing.	After culti- vation.	Harvesting.	Total
Early Maize... 	18	10	16	8	52
Yams 	23	18	61	34	136
Late Maize	26	14	5	4	49

TABLE No. 12.

COMPARISON OF COSTS OF PRODUCTION AND REVENUE FOR
MAIN ROTATION CROPS.

1929-30 SEASON, OGBA FARM.

Cost of labour 11d. per man-day.

CROPS.	Cost of crops in man-days per acre.	Average yield in lb. per acre.	Cost of pro- duction of crop in man- days per lb.	Market value per lb. at store.	Calcula- ted return per acre.	Monetary return per man-day.	Kind of crop.
Early Maize	52	627	·083	·611d.	383d.	7·36d.	Dry grain.
Late Maize	49	464	·105	·750d.	348d.	7·10d.	„ „
Yams Gross	136	5,034	·027	·480d.	2,416d.	17·75d.	Tubers.
Nett	136	1,853	·073	·480d.	889d.	6·53d.	„

Note:--Monetary return per man-day for maize smaller than 1928 owing to low yields of maize. Nett return from yams smaller than 1928 owing to weight of yams planted not being recorded in that year, and nett returns were thus approximate only.

RAINFALL 1929.
Ogba Plantation, Benin.

Month.			Rainfall in inches.	Average rainfall for previous six years, 1923-28.
January ...	...	...	·39	1·25
February...	...	...	1·57	1·18
March ...	...	...	1·49	3·82
April ...	...	...	5·80	6·20
May ...	...	...	9·43	7·28
June ...	...	...	15·55	12·06
July ...	...	...	15·25	10·82
August ...	...	...	7·01	6·77
September	...	...	11·07	11·08
October ...	...	...	14·11	10·34
November	...	...	1·69	2·44
December	...	...	·21	1·23
Total ...	...	...	83·57	74·47

UMUAHIA STATION: FARM ANNUAL REPORT: 1929.

The following officers were in charge during the year:—

Mr. D. H. Urquhart, B.Sc., from 1st January to 25th September, 1929.

Mr. L. P. Henderson, M.A., B.Sc., from 26th September to 31st December, 1929.

INTRODUCTION.

The experiments commenced previously in connection with both Annual and Permanent crops have been continued on the same lines as last season, and, in addition, the following new experiments have been started this year:—

- a) *Yam time of planting*—To compare the effect of planting in early January, February and March.
- b) *Green manuring experiment*—To compare the effect on the fertility of the soil of continuous cropping with Maize and Mucuna intersown, *versus* Maize every second year alternating with Mucuna alone.
- (c) *Yam variety experiment*—To compare the yields of four varieties of Yams grown in this district viz., Jike, Accru Jioku and Oyinta.
- (d) *Land exhaustion*—To observe the effect of growing an annual crop of Yams followed by calopogonium over a series of years.
- (e) *Kola*—To establish a block of Kola for future experiments.

RAINFALL.

The rainfall for the year was below average and was abnormally low during the critical planting months of February, March and April as shown by the following figures:—

Month.			Rainfall to the end of each month.	
			1929.	Average 1921-28.
January	...	...	0.00	1.17
January-February	...	...	.58	2.40
January-March	...	...	3.76	8.36
January-April	...	...	7.02	17.76
January-May	...	...	18.48	30.90
Total	...	...	89.81	101.18

In spite of this shortage of rain in the early part of the year satisfactory yields were obtained from all crops.

ANNUAL CROPS.

Yams.—The average gross yield of yams for the farm worked out at practically 3 tons per acre (6,698 lb.) which must be considered as very satisfactory. This is a considerable increase on last year's average (2 tons) but it should be noted that this increase is partly due to the high yields obtained from N4-28 where a good crop was to be expected after five years "bush" fallow. A fair yield (4,547 lb. per acre) was obtained on M1-25 in its sixth year of intensive rotation.

Early Maize.—Early maize was a fairly good crop, the average yield being 895 lb. dry grain per acre. It is satisfactory to note that the heaviest yield (1,380 lb.) was obtained on block Q35-51 in its third year of intensive cultivation. The lowest yield (271 lb.) was recorded on M1-25 which has now been under a yams, maize, groundnuts rotation for six years. The maize yield on these plots has declined steadily since 1926 when the heaviest crop was obtained.

Late Maize.—Late maize was again a complete failure which further confirms that it cannot be successfully grown here as a late-crop.

Groundnuts.—Only one acre of groundnuts was grown, as part of rotation (M1-25). A moderate yield of 698 lb. per acre was obtained, which is a distinct improvement on the crops of the previous two years, but below the average yield (991 lb.) on the same block in 1927.

Benniseed.—As a further attempt to solve the problem of finding a suitable late crop for this district, it was decided to give Benniseed a trial, and a $\frac{1}{4}$ acre plot was planted with this crop. The yield of 200 lb. dry seed per acre obtained, on unstumped land, is considered very satisfactory and it is proposed to make more extensive trials of this crop next year.

COVER CROPS.

Whilst *Calopogonium* has undoubtedly proved itself to be the most satisfactory crop for use as a cover in the latter half of the wet season and for the dry season, there is no evidence to show that its residual value as a green manure is superior to any of the others grown; in fact the result obtained from the experiment on D1-41 tends to show the reverse. Neither *Calopogonium*, *Crotalaria* nor

Centrosema develop sufficiently rapidly to form an adequate cover in the early part of the year, and in this respect they are inferior to the faster-growing *mucuna* for use as green manure in preparation for a late season crop.

PERMANENT CROPS.

Coffee.—The five acre block of coffee planted in 1928 continues to make excellent progress and is very healthy in appearance. Most of the trees commenced flowering during the latter part of the year, though only a very small percentage of these “set seed.”

Cocoa.—Of the three blocks of cocoa, one (J26-30) is a definite failure and has been abandoned. The larger block J31-40 has made a little progress during the year, but cannot be considered as satisfactory; this poor development may in part be attributed to poor soil conditions, as indicated by the very low yield (1,000 lb. per acre) of *Coco-yams* obtained on this land, as compared with the yield (5,000 lb.) of the same inter-crop grown amongst young palms elsewhere on the farm. The small area of *Cocoa* planted in 1927 on block C1-10 has made better progress and appears to be healthy.

Kola.—A five acre block of kola (J31-40 transplanted from the nursery in May is now well established and appears to be thriving. Good progress has also been made by the kola planted in 1927 on block C1-10.

EXPERIMENT I.

D1-41. Cover Crop Experiment. Maize Test Crop (Table 1). In 1928 three cover crops—*Calopogonium*, *Centrosema* and *Crotalaria* were tested against *Mucuna* with a view to observing their growth and progress and comparing their residual effects as green manure for early crops. The conclusions drawn, were that while *Mucuna* was the quickest grower and formed, probably, the densest cover, it died down before the dry season set in; *Centrosema* and *Calopogonium*, though slow in developing, formed a good cover and lasted well into the dry season, especially *Calopogonium* which formed a very considerable bulk of dry material; *Crotalaria* was slowest in “coming away” after germination, and give a very irregular cover which, however, lasted well.

This year early maize was planted as a test crop and gave a satisfactory yield throughout the block. No significant figures were obtained, except for maize following *Calopogonium* which was shown to have a residual effect apparently inferior to that of *mucuna* in spite of its superiority in affording a good cover throughout the dry season. No useful conclusion can be drawn from this experiment until it has been repeated for several years.

	Lb. maize in dry grain per acre.	Odds that difference is significant.
Average yield of 19 plots following Mucuna	1,555	—
Average difference of 6 plots following Centrosema	+ 46 ± 92	2 : 1
Average difference of 6 plots following Calopogonium	— 165 ± 92	27 : 1
Average difference of 6 plots following Crotalaria	— 80 ± 92	4 : 1

EXPERIMENT II.

D42-50. Yam time of planting Experiment (Table 2).

In this experiment equal numbers of seed of the three varieties Jike, Nkiliti and Apuji were sown in each plot. The figures obtained were definitely in favour of planting in early February and January as against early March. Early February would appear to be the optimum time of planting, though the experiment would need to be repeated in order to obtain a conclusive result.

	Gross yield tubers per acre.	Odds that difference is significant.
Average yield of 5 controls sown 7/3/29	4,486	—
„ difference of 2 plots sown 7/1/29	+ 1,097 ± 291	11,100 : 1
„ „ „ 2 „ „ 2/2/29	+ 1,460 ± 291	over 33,000 : 1

EXPERIMENT III.

D51-61. Maize Spacing Experiment. (Table 3).

This crop of maize was fairly good, being considerably better than that obtained in 1927. The soil would appear to have benefited from the whole season crop of mucuna grown in 1928.

The figures obtained show little difference in yield between the two spacing.

	Lb. dry grain per acre.	Odds that difference is significant.
Average yield 6 controls 2 ft. spacing	935	—
„ difference 5 plots 1 foot spacing	+ 99 ± 127	4 : 1

EXPERIMENT IV.

F1-9. Yam Spacing Experiment (Table 4).

This block was originally intended for a Sulphate of Ammonia manuring experiment, and with that object in view was planted throughout with yams, 4 feet spacing, on February 27th. As no Sulphate of Ammonia was available it was later decided to convert it into a tentative experiment to gain some information on the best

planting distance for yams. This was done by doubling the number of "sets" in the experimental plots. The results cannot therefore be considered as reliable as all the seed on the controls and half on the experimental plots were planted in February 27th, while the remainder of seed on the experimentals was not sown till March 18th.

A good yield of yams was obtained on the control plots only; the experimental plots produced a disappointing crop. The tubers from the latter were much smaller than from the former, and the difference in nett yields was insignificant.

	Lb. tubers per acre.	Odds that difference is significant.
Average nett yield of 5 controls 4 ft. spacing	6,474	—
„ difference „ 4 „ 2 ft. „	+ 25 ± 567	—

EXPERIMENT V.

M26-32. Late Mucuna versus Late Dolichos as a preparation for Early Maize (Table 5).

A uniformly poor crop of maize was obtained this year, the yields being slightly in favour of mucuna, though the difference is not significant.

Mucuna gave a slightly better cover than Dolichos, but both were very poor, the result probably of planting too late (caused by difficulty in obtaining a supply of Dolichos seed).

	Lb. dry grain per acre.	Odds that difference is significant.
Average yield of 4 plots following Mucuna	375	—
„ „ „ 3 „ „ Dolichos	— 79 ± 78	5 : 1

EXPERIMENT VI.

N4-28. Yam variety Experiment (Table 6a and 6b).

A very good yield of yams was obtained throughout this block which was somewhat to be expected as the land had been in "bush" the previous five years.

Jioku which is the most widely grown yam in this neighbourhood gave a significantly larger yield, while Accru was definitely inferior. This land probably suited Jioku which is a variety usually grown by the native farmer on lighter soils. Jike and Accru are

usually planted on heavier soils if possible, so the yield of Jike obtained in this case may be considered as particularly satisfactory. Results have been worked out on nett yields as well as on gross. In the case of Jioku, "nett" results emphasise those obtained from the gross yields; in the case of Accru and Oyinta the significance is reduced although Accru is still significant.

(a) *Gross yields.*

		Yield of tubers per acre.	Odds that difference is significant.
Average yield of 13 plots	Jike	8,884	—
" difference of 4 plots	Accru	— 1,370 $\pm$ 449	740 : 1
" " " 4 "	Jioku	+ 1,023 $\pm$ 449	92 : 1
" " " 4 "	Oyinta	— 727 $\pm$ 449	17 : 1

(b) *Nett yield.*

Average yield of 13 plots	Jike	6,630	—
" difference of 4 plots	Accru	— 839 $\pm$ 455	27 : 1
" " " 4 "	Jioku	+ 1,576 $\pm$ 455	4,350 : 1
" " " 4 "	Oyinta	— 506 $\pm$ 455	5 : 1

OIL PALMS.

All oil palms on the farm generally made very good progress. A large number of the palms on blocks H1-49 which were planted in 1925, or earlier, came into bearing during the year. Calopogonium was used as a cover crop on all blocks except H51-69 and C1-10. This cover did extremely well and it would seem to be the best so far tried for planting through permanent crops. Desmodium was established through the Deli palms and gave a very useful cover which lasted well all through the dry season; it does not seem, however, to be sufficiently thick growing to suppress the more vigorous weeds.

The only area of palms which did not have an adequate cover crop throughout the year was Block H51-69: Mucuna was established on this block and formed a fairly good cover until staked for seed (in July) after which it deteriorated rapidly, and had all died back by October.

The Deli Oil Palms established in block C1-10 and the Calabar seedlings in the variety test (G31-49) made good growth. Blanks due to depredations of "Cutting grass" unfortunately cannot be supplied on the former area owing to lack of seed; on the latter there remain a few stands to be supplied when the seedlings of the required type are available from Calabar.

*H21-29. Oil Palms in Coppiced and cropped land versus
Oil Palms in land Coppiced only (Table 7).*

The better development of the palms in the cropped land compared with those in the adjacent plots is distinctly noticeable. Their difference is not only confined to the size of the individual trees but is also apparent in the relative numbers of bearing trees under the different treatments, there being twice as many on the cropped plots as on the uncropped. Details are given in Table 7.

*H31-39. Oil Palms on Coppiced and cropped land versus Oil
Palms in stumped and cropped land (Table 8).*

The difference in appearance between the palms under the different treatments, though discernible, is not marked. Reference to previous history of this block will show that before the present experiment was started in 1925, the two "stumped" plots had been cleared and cropped since 1923, whilst the seedlings in the three control plots were growing in 6 ft. ridges in high bush. The resultant superiority of the palms in the stumped plots, previously so marked, becomes less apparent every year and seems likely to disappear altogether if the present rate of progress continues.

A large number of trees came into bearing on all plots during the year, and here again, there is little appreciable difference between the stumped and unstumped plots. From these observations it would appear that the advantages of stumping, an expensive operation, have relatively little effect on the development of the permanent crops.

*H41-49. Oil Palms in Continuously cropped land versus
Oil Palms in land once farmed and allowed to go to bush (Table 9).*

The palms in the continuously cropped land are superior in every way to those in the bush plots. There is a marked difference in the relative numbers of bearing trees in the different plots—35% on the cleared against only 1.5% in the "bush" plots. A very satisfactory crop of Coco-yams was obtained off the cropped plots (4,850 lb. per acre). Calopogonium intersown with the Coco-yams formed a fair cover only.

TABLE No. 1.

D1-41—COVER CROP EXPERIMENT—MAIZE TEST CROP.

Plot No.	Late season Treatment.	Crop.	Yield per acre dry grain (lb.)	Increase (+) or decrease (—) compared with mean of adjacent controls.
D 1	Mucuna	Maize	1,252	
2	Centrosema	"	1,304	— 82
3	Mucuna	"	1,520	
4	Calopogonium	"	1,312	— 418
5	Mucuna	"	1,940	
6	Crotalaria	"	1,344	— 344
7	Mucuna	"	1,436	
8	Centrosema	"	1,388	— 30
9	Mucuna	"	1,400	
10	Calopogonium	"	1,228	— 28
11	Mucuna	"	1,112	
12	Crotalaria	"	1,084	+ 46
13	Mucuna	"	964	
14	Centrosema	"	820	— 102
15	Mucuna	"	880	
16	Calopogonium	"	780	— 64
17	Mucuna	"	808	
18	Crotalaria	"	876	+ 34
19	Mucuna	"	876	
20	Centrosema	"	1,028	+ 112
21	Mucuna	"	956	
22	Calopogonium	"	968	— 18
23	Mucuna	"	1,016	
24	Crotalaria	"	820	— 118
25	Mucuna	"	860	
26	Centrosema	"	1,228	+ 288
27	Mucuna	"	1,020	
28	Calopogonium	"	932	— 168
29	Mucuna	"	1,180	
30	Crotalaria	"	1,168	...
31	Mucuna	"	1,156	
32	Centrosema	"	1,392	+ 88
33	Mucuna	"	1,452	
34	Calopogonium	"	1,008	— 292
35	Mucuna	"	1,148	
36	Crotalaria	"	968	— 96
37	Mucuna	"	980	...
38	Non Experimental ...	"	...	...
39	" "	"	...	...
40	" "	"	...	...
41	" "	"	...	...

Average 1,155

Each plot $\frac{1}{4}$ acre. Ridges 6 feet. Planting distance 2 rows 1 plant per stand
 $1\frac{1}{2}$ feet staggered.

TABLE NO. 1—*continued*.

Maize sown March 26th. Harvested July 20th-24th,

Root—mean—square—difference between adjacent control plots = 226 lb. per acre.

Average yield of 19 plots following Mucuna = 1,155 lb. per acre.

„ difference 6 „ „ Centrosema = $+ 46 \pm 92$ per acre.

„ „ 6 „ „ Calopogonium -165 ± 92 „ „

„ „ 6 „ „ Crotalaria ... $- 80 \pm 92$ „ „

Cost of cultivation in man-days per acre = 128

TABLE No. 2.

D42 50 YAMS—TIME OF PLANTING EXPERIMENT.

Plot.	Treatment.	Crop.	Yield per acre (gross).	Increase (+) or decrease (—) com- pared with mean of adjacent controls.
D 42	7th March, 1929 ...	Yams	4,640	
43	7th January, „ ...	„	5,784	+ 1,400
44	„ March, „ ...	„	4,128	
45	„ February, „ ...	„	5,888	+ 1,580
46	„ March, „ ...	„	4,488	
47	„ January, „ ...	„	5,204	+ 794
48	„ March, „ ...	„	4,332	
49	„ February, „ ...	„	5,928	+ 1,340
50	„ March, „ ...	„	4,844	
Average			4,486	

Each plot $\frac{1}{4}$ acre. Ridges 6'. Spacing 4' staggered.

Yams harvested—October 4th.

Root—mean—square—difference between adjacent control plots = 412 lb. per acre.

Average yield of 5 control plots sown 7th March, 1929 = 4,486 lb. per acre.

„ difference 2 plots „ „ January, „ = $+1,097 \pm 291$.

„ „ 2 „ „ February, „ = $+1,460 \pm 291$.

Cost of cultivation in man-days per acre = 214.

TABLE No. 3.
D51-61—MAIZE SPACING.

Plot.	Treatment.			Yield per acre dry grain (lb.)	Increase (+) or decrease (-) compared with mean of adjacent controls.
D 51	2 feet spacing	...	...	996	
52	1 foot "	...	...	1,232	+ 400
53	2 feet "	...	...	668	
54	1 foot "	...	...	872	+ 26
55	2 feet "	...	...	1,024	
56	1 foot "	...	...	1,000	+ 114
57	2 feet "	...	...	748	
58	1 foot "	...	...	896	+ 10
59	2 feet "	...	...	1,024	
60	1 foot "	...	...	1,028	- 58
61	2 feet "	...	...	1,148	
Average				935	

Each plot $\frac{1}{4}$ acre. 6 feet ridges. Maize sown March 23rd.

" harvested July 18th.

Root—mean—square—difference between adjacent control plots = 284 lb. per acre.

Average yield of 6 control plots = 935 lb. per acre.

" difference of 5 plots with 1 foot spacing + 99 $\pm$ 127.

Cost of cultivation in man-days per acre = 70.

TABLE No. 4.
F1-9—YAM SPACING TEST.

Plot.	Treatment.				Nett yield per acre (lb. tubers.)	Increase (+) or decrease (-) com- pared with mean of adjacent controls.
F 1	4 feet staggered	...	...	...	5,308	
2	2 "	"	...	...	5,884	- 260
3	4 "	"	...	...	6,980	
4	2 "	"	...	...	7,172	+ 182
5	4 "	"	...	...	7,000	
6	2 "	"	...	...	6,360	- 126
7	4 "	"	...	...	5,972	
8	2 "	"	...	...	6,848	- 306
9	4 "	"	...	...	7,112	
Average				...	6,474	

Each plot $\frac{1}{4}$ acre. Ridges 6 feet. Yams sown February 27th and March 18th.

" harvested October 8th.

Root—mean—square—difference between adjacent controls = 1,135.

Average nett yield of 5 control plots = 6,474 lb. per acre.

" difference " 4 plots 2 feet spacing = + 25 $\pm$ 567.

Cost of cultivation in man-days per acre = 172.

TABLE No. 5.

M26-32—MUCUNA AND DOLICHOS AS PREPARATION
FOR EARLY MAIZE.

Plot.	Treatment.				Yield per acre of Maize (lb. dry grain.)		Increase (+) or decrease (−) com- pared with mean of adjacent controls.
M 26	Mucuna	...	...	...	244		
27	Dolichos	...	...	...		316	— 40
28	Mucuna	...	...	...	468		
29	Dolichos	...	...	...		368	— 76
30	Mucuna	...	...	...	420		
31	Dolichos	...	...	...		272	— 122
32	Mucuna	...	...	...	368		
Average					...	375	

Each plot $\frac{1}{4}$ acre. Ridges 6', 2 rows $1\frac{1}{2}'$ staggered 1 plant per stand.

Maize sown March 19th. Maize harvested July 15th.

Root—mean—square—difference between adjacent control plots = 136 lb.
per acre.

Average yield of 4 control plots = 375 lb. per acre.

„ difference 3 plots sown after Dolichos = — 79 ± 78 .

Cost of cultivation in man-days per acre = 87.

TABLE No. 6a.

N4-28—YAM VARIETY EXPERIMENT.

Plot.	Variety.	Crop.	Gross yield per acre lb. Tuber.	Increase (+) or decrease (—) com- pared with mean of adjacent controls.
N 4	Jike	Yams	8,168	
5	Accru	"	7,952	— 1,030
6	Jike	"	9,796	
7	Jioku	"	11,756	+ 1,528
8	Jike	"	10,660	
9	Oyinta	"	8,692	— 1,648
10	Jike	"	10,020	
11	Accru	"	7,272	— 2,240
12	Jike	"	9,004	
13	Jioku	"	9,692	+ 178
14	Jike	"	10,024	
15	Oyinta	"	9,312	— 548
16	Jike	"	9,696	
17	Accru	"	7,292	— 1,618
18	Jike	"	8,124	
19	Jioku	"	8,908	+ 690
20	Jike	"	8,312	
21	Oyinta	"	7,796	— 546
22	Jike	"	8,372	
23	Accru	"	7,596	— 590
24	Jike	"	8,000	
25	Jioku	"	9,776	+ 1,696
26	Jike	"	8,160	
27	Oyinta	"	7,488	— 168
28	Jike	"	7,152	
Average			8,884	

Each plot $\frac{1}{4}$ acre. 6 feet ridges 4 feet staggered. Yams planted February 20th.

„ harvested October 10th.

Root—mean—square—difference between neighbouring control plots = 898 lb.
per acre.

Average yield of 13 plots Jike 8,884 lb. per acre.

„ difference 4 „ Accru = $-1,370 \pm 449$.

„ „ 4 „ Jioku = $+1,023 \pm 449$.

„ „ 4 „ Oyinta = -727 ± 449 .

Cost of cultivation in man-days per acre = 179.

TABLE No. 6b.
N4-28. YAM VARIETY EXPERIMENT.

Plot.	Variety.	Crop.	Nett yield per acre lb. Tubers.		Increase (+) or decrease (-) compared with mean of adjacent controls.
N 4	Jike ...	Yams	5,972		
5	Accru ...	"		6,224	- 552
6	Jike ..	"	7,580		
7	Jioku ...	"		9,768	+1,720
8	Jike ...	"	8,516		
9	Oyinta ...	"		6,536	-1,582
10	Jike ...	"	7,720		
11	Accru ...	"		5,524	-1,710
12	Jike ...	"	6,748		
13	Jioku ...	"		7,996	+ 854
14	Jike ...	"	7,536		
15	Oyinta ...	"		7,104	- 456
16	Jike ...	"	7,584		
17	Accru ...	"		5,568	-1,080
18	Jike ...	"	5,712		
19	Jioku ...	"		7,308	+1,508
20	Jike ...	"	5,888		
21	Oyinta ...	"		5,948	- 70
22	Jike ...	"	6,148		
23	Accru ...	"		5,976	- 14
24	Jike ...	"	5,832		
25	Jioku ...	"		8,072	+2,224
26	Jike ...	"	5,864		
27	Oyinta ...	"		5,560	+ 82
28	Jike ...	"	5,092		
	Average ...	"	6,630		

Root-mean-square-difference between neighbouring control plots = 911 lb. per acre.

Average yield of 13 plots	Jike	6,630 lb. per acre
" difference 4 "	Accru	- 839 $\pm$ 455
" " 4 "	Jioku	+ 1,576 $\pm$ 455
" " 4 "	Oyinta	- 506 $\pm$ 455

TABLE No. 7.
H21-29. OIL PALM YIELDS JANUARY 1ST, 1929 TO DECEMBER 31ST, 1929.

Plot.	Experiment.	Treatment.	No. of Bunches.	Weight of Bunches. lb.	Weight of Fruit. lb.	Average weight of Bunch. lb.	Average weight of fruit per Bunch.	No. of bearing trees.	
								January.	December.
H 21	Coppiced and	Calopogonium	225	646	lb.	lb.	lb.	4	35
H 23	Cropped	...	...	...	...	...	...	...	...
H 25	Coppiced only	Bush cut back	38	102 $\frac{1}{2}$	70	2.6	1.8	0	13
H 27	Coppiced and	Calopogonium	126	328 $\frac{3}{4}$	222	2.6	1.7	4	28
H 29	Cropped	...	...	...	...	...	...	...	...
H 29	Coppiced only	Bush cut back	68	206	134 $\frac{1}{2}$	3.02	1.9	2	15
H 29	Coppiced and	Calopogonium	205	675 $\frac{1}{2}$	406 $\frac{3}{4}$	3.2	1.9	1	33

All plots = 1 acre.
Palms planted 25 ft. $\times$ 25 ft.
Number of palms per acre = 65.

TABLE No. 8.
H31-39. OIL PALM YIELDS—JANUARY 1ST, 1929 TO DECEMBER 31ST, 1929.

Plot.	Experiment.	Treatment.	No. of Bunches.	Weight of Bunches.		Weight of Fruit.	Average weight of Bunch.		Average weight of fruit per Bunch.		No. of trees bearing.	
				lb.	lb.		lb.	lb.	lb.	lb.	January.	December.
H 31	Coppiced and cropped	Calopogonium ...	416	1,388	lb.	874½	3.3	lb.	2.1	53	5	
H 33	Stumped and cropped	Calopogonium ...	965	2,029½		1,321½	2.1		1.3	51	7	
H 35	Coppiced and cropped	Calopogonium ...	254	809½		488½	3.1		1.9	47	4	
H 37	Stumped and cropped	Calopogonium ...	364	1,747½		1117½	4.8		3.06	49	5	
H 39	Coppiced and cropped	Calopogonium ...	253	785½		480½	3.1		1.8	43	5	

All plots = 1 acre.
Palms planted 25 ft. × 25 ft.
Number of palms per acre = 65.

TABLE No. 9.
H41-49—OIL PALM YIELDS JANUARY 1ST, 1929—DECEMBER 31ST, 1929.

Plot.	Experiment.	Treatment.	No. of Bunches.	Weight of Bunches.	Weight of Fruit.	Average Weight of Bunches.	Average weight of fruit per Bunch.	No. of trees bearing.	
								January.	December.
H 41	Continuous Cropping ...	Coco-yams and Calopog.	223	757 lb.	433½ lb.	3.3 lb.	1.9 lb.	0	34
H 43	Bush ...	Bush	10	19½ "	9½ "	1.9 "	0.9 "	0	2
H 45	Continuous Cropping ...	Coco-yams and Calopog.	79	225½ "	167 "	2.8 "	2.1 "	0	19
H 47	Bush ...	Bush	0	0 "	0 "	0 "	0 "	0	0
H 49	Continuous Cropping ...	Coco-yams and Calopog.	71	198 "	126 "	2.8 "	1.7 "	0	15

All plots = 1 acre.

Palms planted 25 ft. × 25 ft.

Number of palms per acre = 65

TABLE No. 10.

RAINFALL 1929.

Month.	Rainfall in inches, 1929.				Average Rainfall for eight years 1921 to 1928.
January	0·00				1·17
February	0·58				1·23
March	3·18				5·96
April	3·26				9·40
May	11·46				13·14
June	14·16				15·14
July	11·86				10·39
August	13·86				11·61
September	15·04				15·45
October	12·59				11·44
November	3·54				4·18
December	0·28				2·07
Totals	89·81				101·18

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BY

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OIL PALMS.

Grove Replanting Experiments.—The recording of yields has been continued on all the Palm Grove Replanting Experiments commenced in 1927, with the exception of two of the smaller plots, both in Okigwi district, which have been abandoned owing to the lack of interest shown by the owners.

A further three experiments have been commenced—two, each of nine half acre plots, at Azumini, and one of nine one acre plots near Calabar—but in view of the number of representative plots already under observation and of the fairly conclusive results obtained, it is considered unnecessary to record yields from these new areas.

2. As was found last year, the average yield on “cleared” plots is in every case higher than that on the adjacent “bush” plots. Easier accessibility of trees for harvesting on the “improved” plots probably accounted for the higher yields obtained on these as compared with the bush plots, in 1928; this year’s records show, with one exception, a substantial increase in the average yields from the cleared plots over the yields obtained on the same plots last year. This increase can be partly accounted for by the fact that some young palms have commenced bearing this year, but, after allowing for this and for the natural increase in yield of immature palms, it might safely be assumed that the increase is due in part to the fact that some of the palms have responded during the past two years to the improved conditions on the cleared areas.

3. The exception to this (referred to in paragraph 2 above) is Ikparakwa B plots where the average yield from cleared plots is slightly below last year’s figure though still larger than that of the adjacent “unimproved” plots. The palms on this land are nearly all tall growing and past their optimum bearing age; many were cut out in June 1929 in order to improve shade conditions for the young planted seedlings, and it seems reasonable to assume that the remaining trees, being so old, have not responded to treatment

sufficiently readily to discount, by increased yield, the loss resulting from this thinning out. The adjacent "bush" plots show a slight increase in average yield over last year's figures which is probably caused by a few young palms coming into bearing this year.

4. The results of yields from the bush plots on the different experiments are less uniform: two show a decrease, four a slight increase and four a fairly considerable increase on the previous year. These variations appear to be closely co-related with the accessibility or otherwise of the bearing palms: when the undergrowth is heavy or many young palms crowded together, as on Akpabuyo plots, undoubtedly a fair amount of the fruit is not collected; where the "bush" is light and there is easy access to the bearing palms as at Azumini, harvesting is more thorough and the yield is maintained or, where many new palms are coming into bearing, increased.

5. As last year, the fruit is harvested by the owners and weighed by the clerk in charge before being removed. It is considered that the records of yields so obtained are fairly accurate, at least in the case of the *total* yields; there is possibility of inaccuracy occurring in "yields per tree" particularly on the "unimproved" plots where it is less easy to check the origin of the fruit collected, owing to the difficulty of supervising a large number of harvesters in, what is often, dense "bush." This system of harvesting gives a fair indication of results likely to be obtained under "native practice" although it is thought that even on the "bush" plots more fruit is collected now than was the case before these came under experimental treatment and supervision. It would be interesting to observe the effect of more thorough harvesting on the relative yields of "cleared" and of "bush" plots, and it is hoped that some information will be obtained on this point next year if it can be arranged that the harvesting of fruit on the Aba plots be done entirely by our own labourers.

6. The records of yields obtained this year not only tend to confirm the conclusion, drawn from 1928 figures, that improvement of palm bush can be affected without a fall in yield, but, further, to indicate that a substantial increase in yield may be expected when this method of improvement is carried out on average palm grove containing a fair number of immature palms which are likely to respond quickly to the improved conditions. Where the grove consists chiefly of tall over-crowded palms past their prime bearing age, which should all be supplanted as early as possible by healthy young palms, the yield is likely to remain stationary or may even

decline, at least temporarily, as many of these trees have to be thinned out as at Ikparakwa B). Compared with the other experimental plots, this type of dense palm bush is exceptional, but may be typical of the large palm belt (Abak, etc. area) of which it is part, although it is considered this low percentage of young palms is unusual.

7. Further experience has been gained with regard to practical details of spacing, size of seedling, etc. It is evident that in areas where the old palms are dense, extensive thinning out is required in order to obtain suitable conditions for the young planted seedlings. In many cases, however, it is found advisable to proceed gradually with thinning out as the farmers are frequently reluctant to cut out a large number of palms at any one time. Where there is too much shade as a result of insufficient thinning-out of old palms, as at Ikparakwa B, the seedlings are not so well forward as could be desired; on plots where shade conditions are more favourable, the seedlings have progressed well, as at Azumini.

8. Further observation is required to determine the optimum size of "bush" seedling for planting. It has been found that large seedlings (four feet to six feet high) if carefully transplanted can be established almost as quickly as smaller ones. At the same time it remains to be seen whether the check to growth, which is likely to result from transplanting at this stage, will be serious enough to discount their present advantage in age and size. Until more experience is gained on this point it is considered that robust seedlings from two feet to two and-a-half feet in height should be used.

9. It is probably better to plant only one seedling at a stand rather than two or three as has been done previously. It was hoped by the latter method to avoid the expense and delay of supplying and to afford an opportunity for a certain amount of selection, the intention being to thin out all but the best seedling after they were well established. In practice it is found that where proper attention is given, very few of the seedlings fail to become established so that extensive supplying is not required; and it is likely that harmful competition occurs amongst the seedlings before they are sufficiently well-grown to allow of a useful selection being made. Further, the additional cost of planting two or three seedlings, rather than one, is an important consideration, particularly when suitable "bush" seedlings are scarce.

Oil Palm Plantations:—The policy of encouraging farmers to plant up areas with oil palms has been continued, and a further thirty-five small plantations totalling 115 acres have been established. In every case supervision was given for lining, holing and planting and,

particularly in such districts as Abak, Ikot-Ekpene, etc. where no demonstration plots existed and it was considered advisable to have something of the nature, a certain amount of assistance in the form of labour was given in the early stages. When planting operations were completed, the owners themselves were left to look after the plantations under our guidance. With the exception of some of the smaller plots, these are all now established and in many cases are being maintained in good condition. Of the areas opened up last year, two are receiving very little attention and one has been definitely abandoned; those at Azumini, Ikparakwa and Oron are progressing particularly well.

10. There is now a total of approximately 160 acres of these small plantations which vary in size from one to twelve acres. Though their economic value is in most cases small owing to their small area, yet they should prove of considerable importance for demonstration purposes if they are maintained until they come into bearing, when the possibilities of this form of land improvement may become more apparent to the native farmers. The system of communal ownership of land is found to be a drawback to rapid development of this side of the work; it is rarely found that all members of a community are equally progressive in outlook and all prepared to try this method of improving their land, and the few attempts at establishing a communal plot (as at Ameki) have not met with success. It is usually found that the larger plantations are owned by Chiefs who have a considerable amount of influence amongst their people, or by persons who have in some manner acquired individual rights to the land. The plantations owned by the latter usually receive better treatment. The native customs regulating communal ownership of palms are very strict and are a further obstacle to progress in improvement of palm groves.

A few of the "plantations" contain fairly dense patches of old palms, but usually the areas selected for this purpose have very few palms growing on them and would not come under the category of "palm bush."

11. It had been hoped that the owners of these plots and plantations would interplant the palm seedlings with annual crops, as this would, by providing some income, minimise the cost of opening up and at the same time the young palms would benefit from the inter-cultivation. In practice it has been found, however, that except in a very few cases, they are very reluctant to do so, even on land which has not been cropped for five years or more. It may be possible to convince them of the value of intercropping by carrying it out on small demonstration areas.

Palm Oil Machinery.—The work of demonstrating hand-power Oil Presses and Nutcrackers with a view to persuading the farmers to adopt these machines has been continued throughout the year, and some progress has been made, particularly in Calabar Province where a number of machines have been taken up and a demand for them continues. The number of these machines at present in use are as follows:—

Province.		Oil Presses.	Nutcrackers.
Owerri ...	...	2	4
Calabar...	...	10	8
Onitsha	...	3	2

A scheme is already in operation in Calabar Province whereby these machines may be purchased on a hire purchase system; this probably accounts for the larger numbers which have recently been taken up in this Province. It seems likely that if similar facilities for instalment purchase existed elsewhere a greater interest might be shown in these machines, as the initial high cost undoubtedly prejudices the average farmer against them. Another difficulty is that frequently the person who realises the advantages of the Oil Press system does not possess a sufficient quantity of fruit to justify him acquiring a press solely for his own use and cannot persuade other members of the village to join him in some Co-operative arrangement for using one. A possible solution to this problem may be found in the system successfully adopted by the owner of an Oil Press and Nutcracker at Azumini: in addition to extracting his own oil he treats his neighbours' fruit at a fixed rate per measure, an arrangement which has been working for some time and appears satisfactory to both parties. Some of the farmers who have recently acquired these machines in certain Calabar districts hope to adopt the same system if they can persuade their neighbours to bring their fruit for treatment.

Cocoa.—Cocoa appears to be a fairly good crop this season but quality has in most cases proved disappointing. Fermenting sheds under our supervision were opened in Aro-Chuku district only; about 15 tons were fermented and sold at Itu, the highest price offered being £28 per ton. It would appear that the growers in Itu district are less careful in the preparation of their cocoa, and when direct supervision has been withdrawn have not kept up the standard attained under previous instruction. Much of the cocoa offered for sale this year was of very poor quality, with the result that low prices only were obtained and many of the firms

stopped buying before the end of the season. No figures are available for Calabar district. Sheds were not opened at Azumini this year; most of the cocoa from this district was sold in Opobo where better prices appear to have been offered. Some interest was shown in this crop in certain districts, particularly in the Enyong Creek area, and small areas were planted up there earlier this year and also at Akwete and Imo-River (Aba).

SUMMARY OF YIELDS.

PALM GROVE REPLANTING EXPERIMENTS.

						Yield of bunches per acre.	
						1928.	1929.
Akpabuyo A	...	...	6 plots, each 1 acre, in bush	...	...	2,081 lb.	2,145 lb.
			5 " " " cleared	...	...	3,043 "	4,231 "
Akpabuyo B	...	...	6 " " " in bush	...	...	2,388 "	1,828 "
			5 " " " cleared	...	...	2,550 "	3,307 "
Akpabuyo C	...	...	5 " " " bush	...	...	1,086 "	1,002 "
			4 " " " cleared	...	...	1,464 "	2,664 "
Ikparakwa A	...	...	4 " " $\frac{1}{2}$ " in bush	...	...	2,120 "	3,058 "
			3 " " " cleared	...	...	3,150 "	4,696 "
Ikparakwa B	...	...	4 " " $\frac{1}{2}$ " in bush	...	...	2,428 "	2,535 "
			3 " " " cleared	...	...	3,030 "	2,897 "
Azumini	...	...	5 " " $\frac{1}{2}$ " in bush	...	...	1,410 "	2,704 "
			4 " " " cleared	...	...	1,844 "	2,531 "
Aba A	...	...	5 " " 1 " in bush	...	...	457 "	697 "
			4 " " " cleared	...	...	1,035 "	2,148 "
Aba B	...	...	5 " " " in bush	...	...	1,401 "	1,748 "
			4 " " " cleared	...	...	2,259 "	3,007 "
Aba C	...	...	5 " " " in bush	...	...	1,333 "	1,456 "
			4 " " " cleared	...	...	1,399 "	2,653 "
Orlu	...	...	4 " " $\frac{1}{2}$ " in bush	...	...	1,053 "	1,130 "
			3 " " " cleared	...	...	1,559 "	1,846 "
Mean of Bush Plots						1,576	1,830
" " Cleared Plots						2,133	2,998
							Increase.
							254
							865

PALM PLOTS.
BLOCK A.

AREA OF BLOCK—11 ACRES.
AREA OF EACH PLOT— 1 ACRE.
AKPABUYO.

Plot.	Treatment.	Total No. of trees per plot (exclusive of planted seedlings).	Total No. bearing trees per plot.	Total weight lb. bunches harvested per plot January-December.		Average weight lb. bunches harvested per bearing tree Jan.-Dec., 1929.
				1929.	1928.	
1	Bush ...	28	21	3,162	2,602	150
2	Cleared ...	13	11	2,618	1,806	238
3	Bush ...	8	4	1,082	755	270
4	Cleared ...	6	6	2,719	1,511	453
5	Bush ...	10	5	1,554	1,376	310
6	Cleared ...	17	17	4,916	3,180	289
7	Bush ...	29	24	3,299	3,464	137
8	Cleared ...	28	28	7,275	5,976	259
9	Bush ...	17	17	3,225	3,235	189
10	Cleared ...	14	14	3,629	2,746	259
11	Bush ...	9	6	549	1,058	91

					1929.	1928.
Average weight (of bunches) per acre harvested from 6 Bush plots	=	2,145 lb.				2,081 lb.
" " " " " bearing tree " 6	=	167 "				—
" " " " " acre harvested " 5 Cleared "	=	4,231 "				3,043 "
" " " " " bearing tree harvested } " 5 " "	=	278 "				—
Average weight per bunch for Block A	=	46 "				43 "

PALM PLOTS.
BLOCK B.

AREA OF BLOCK—11 ACRES.
AREA OF EACH PLOT— 1 ACRE.
AKPABUYO.

Plot.	Treatment.	Total No. of trees per plot (exclusive of planted seedlings).	Total No. bearing trees per plot.	Total weight lb. bunches harvested per plot January-December.		Average weight lb. bunches harvested per bearing tree Jan.-Dec., 1929.
				1929.	1928.	
1	Bush ...	16	14	1,662	1,861	118
2	Cleared ...	15	13	3,310	2,454	254
3	Bush ...	26	17	1,929	3,028	113
4	Cleared ...	16	16	3,276	2,366	204
5	Bush ...	20	17	2,417	2,894	142
6	Cleared ...	12	12	3,259	2,677	271
7	Bush ...	9	9	1,484	2,026	164
8	Cleared ...	19	18	4,367	3,492	242
9	Bush ...	21	19	2,183	3,177	114
10	Cleared ...	18	18	2,323	1,711	129
11	Bush ...	11	6	1,296	1,341	216

					1929.	1928.
Average weight (of bunches) per acre harvested from 6 Bush plots	=	1,828 lb.				2,388 lb.
" " " " " bearing tree " 6	=	133 "				—
" " " " " acre harvested " 5 Cleared "	=	3,307 "				2,550 "
" " " " " bearing tree " 5	=	214 "				—
Average weight per bunch for Block B	=	47 "				44 "

PALM PLOTS.

AREA OF BLOCK—9 ACRES.

BLOCK C.

AREA OF EACH PLOT—1 ACRE.

AKPABUYO.

Plot.	Treatment.	Total No. of trees per plot (exclusive of planted seedlings).	Total No. bearing trees per plot.	Total weight lb. bunches harvested per plot January–December.		Average weight lb. bunches harvested per bearing tree Jan.–Dec., 1929.
				1929.	1928.	
1	Bush ...	9	5	564	1,015	112
2	Cleared ...	12	7	1,660	1,053	237
3	Bush ...	18	7	1,188	817	169
4	Cleared ...	23	21	3,800	2,805	180
5	Bush ...	24	14	1,841	2,318	131
6	Cleared ...	23	19	2,277	1,324	119
7	Bush ...	13	6	856	888	142
8	Cleared ...	15	13	2,922	674	224
9	Bush ...	19	3	561	393	187

					1929.	1928.
Average weight (of bunches) per acre harvested from 5 Bush plots	=	1,002 lb.				1,086 lb.
" " " " " bearing tree " " 5	=	143 "				—
" " " " " acre " " 4 Cleared "	=	2,664 "				1,464 "
" " " " " bearing tree " " 4	=	177 "				—
Average weight per bunch for Block C	=	46 "				39 "

PALM PLOTS.

AREA OF BLOCK—9 ACRES.

BLOCK A.

AREA OF EACH PLOT—1 ACRE.

ABA.

Plot.	Treatment.	Total No. of trees per plot (exclusive of planted seedlings).	Total No. bearing trees per plot.	Total weight lb. bunches harvested per plot January–December.		Average weight lb. bunches harvested per bearing tree Jan.–Dec., 1929.
				1929.	1928.	
1	Bush ...	9	6	169	306	28
2	Cleared ...	7	7	955	538	136
3	Bush ...	7	3	273	295	91
4	Cleared ...	29	26	2,206	1,367	84
5	Bush ...	29	19	1,200	656	63
6	Cleared ...	73	47	2,880	1,291	61
7	Bush ...	48	21	870	298	41
8	Cleared ...	71	45	2,554	946	56
9	Bush ...	49	29	976	733	33

					1929.	1928.
Average weight (of bunches) per acre harvested from 5 Bush plots	=	697 lb.				457 lb.
" " " " " bearing tree " " 5	=	44 "				—
" " " " " acre " " 4 Cleared "	=	2,148 "				1,035 "
" " " " " bearing tree " " 4	=	68 "				—
Average weight per bunch for Block A	=	20 "				22 "

PALM PLOTS.

AREA OF BLOCK—9 ACRES.

BLOCK B.

AREA OF EACH PLOT—1 ACRE.

ABA.

Plot.	Treatment.	Total No. of trees per plot (exclusive of planted seedlings).	Total No. bearing trees per plot.	Total weight lb. bunches harvested per plot January–December.		Average weight lb. bunches harvested per bearing tree Jan.–Dec., 1929.
				1929.	1928.	
1	Bush ...	37	30	1,536	1,340	51
2	Cleared ...	58	50	3,477	2,509	69
3	Bush ...	25	23	1,563	1,083	67
4	Cleared ...	36	26	2,980	1,628	114
5	Bush ...	30	25	1,492	1,770	59
6	Cleared ...	44	36	2,173	2,133	60
7	Bush ...	44	31	1,563	1,280	50
8	Cleared ...	70	46	3,398	2,765	74
9	Bush ...	37	29	2,586	1,532	89

	1929.	1928.
Average weight (of bunches) per acre harvested from 5 Bush plots =	1,748 lb.	1401 lb.
" " " " " bearing tree " " 5 " " =	63 "	—
" " " " " acre harvested " " 4 Cleared " =	3,007 "	2259 "
" " " " " bearing tree " " 4 " " =	72 "	—
Average weight per bunch for Block B =	28 "	28 "

PALM PLOTS.

AREA OF BLOCK—9 ACRES.

BLOCK C.

AREA OF EACH PLOT—1 ACRE.

ABA.

Plot.	Treatment.	Total No. of trees per plot (exclusive of planted seedlings).	Total No. bearing trees per plot.	Total weight lb. bunches harvested per bearing tree January–December		Average weight lb. bunches harvested per bearing tree Jan.–Dec., 1929.
				1929.	1928.	
1	Bush ...	14	11	718	1,021	65
2	Cleared ...	21	18	1,778	698	98
3	Bush ...	30	22	1,548	1,494	70
4	Cleared ...	34	31	2,590	1,219	83
5	Bush ...	33	24	1,345	1,488	56
6	Cleared ...	31	27	3,755	2,472	139
7	Bush ...	30	20	1,977	1,311	98
8	Cleared ...	36	35	2,492	1,208	71
9	Bush ...	34	27	1,692	1,353	62

	1929.	1928.
Average weight (of bunches) per acre harvested from 5 Bush plots =	1,456 lb.	1,333 lb
" " " " " bearing tree " " 5 " " =	70 "	—
" " " " " acre harvested " " 4 Cleared " =	2,653 "	1,399 "
" " " " " bearing tree " " 4 " " =	95 "	—
Average weight per bunch for Block C =	32 "	30 "

PALM PLOTS.

AREA OF BLOCK— $3\frac{1}{2}$ ACRES.AREA OF EACH PLOT— $\frac{1}{2}$ ACRE.

IKPARAKWA A.

Chief Intefere.

Plot.	Treatment.	Total No. of trees per plot (exclusive of planted seedlings).	Total No. bearing trees per plot.	Total weight lb. bunches harvested per plot January–December.		Average weight lb. bunches harvested per bearing tree Jan.–Dec., 1929.
				1929.	1928.	
1	Bush ...	27	24	1,943	1,403	80
2	Cleared ...	33	27	2,063	1,835	76
3	Bush ...	37	27	1,638	1,363	60
4	Cleared ...	33	31	2,653	1,670	85
5	Bush ..	23	18	1,072	877	59
6	Cleared ...	33	25	2,328	1,220	93
7	Bush ...	22	20	1,463	599	73

				1929.	1928.
Average weight (of bunches) per acre harvested from 4 Bush plots =				3,058 lb.	2,120 lb.
"	"	"	" bearing tree " 4	= 69 "	—
"	"	"	" acre harvested " 3 Cleared "	= 4,696 "	3,150 "
"	"	"	" bearing tree " 3	= 84 "	—
Average weight per bunches for Block				= 35 "	43 "

PALM PLOTS.

AREA OF BLOCK— $3\frac{1}{2}$ ACRES.AREA OF EACH PLOT— $\frac{1}{2}$ ACRE.

IKPARAKWA B.

Chief Anyim's.

Plot.	Treatment.	Total No. of trees per plot (exclusive of planted seedlings).	Total No. bearing trees per plot.	Total weight lb. bunches harvested per plot January–December.		Average weight lb. bunches harvested per bearing tree Jan.–Dec., 1929.
				1929.	1928.	
1	Bush ...	40	37	2,035	1,754	55
2	Cleared ...	33	31	1,459	1,897	47
3	Bush ...	26	24	1,353	1,748	56
4	Cleared ...	31	23	819	980	35
5	Bush ...	26	23	946	535	41
6	Cleared ...	30	27	1,761	1,668	65
7	Bush ...	21	18	737	821	40

				1929.	1928.
Average weight (of bunches) per acre harvested from 4 Bush plots =				2,534 lb.	2,428 lb.
"	"	"	" bearing tree " 4	= 49 "	—
"	"	"	" acre harvested " 3 Cleared "	= 2,692 "	3,030 "
"	"	"	" bearing tree " 3	= 49 "	—
Average weight per bunch for Block				= 29 "	28 "

PALM PLOTS.

AREA OF BLOCK— $4\frac{1}{2}$ ACRES.AREA OF EACH PLOT— $\frac{1}{2}$ ACRE.

AZUMINI.

Plot.	Treatment.	Total No. of trees per plot (exclusive of planted seedlings).	Total No. bearing trees per plot.	Total weight lb. bunches harvested per bearing tree January-December.		Average weight lb. bunches harvested per bearing tree Jan.-Dec., 1929.
				1929.	1928.	
1	Bush ...	5	4	386	104	96
2	Cleared ...	12	8	1,584	1,285	198
3	Bush ...	22	15	1,498	1,013	99
4	Cleared ...	20	14	1,595	800	113
5	Bush ...	11	10	1,515	692	151
6	Cleared ...	6	6	774	1,125	129
7	Bush ...	10	9	1,794	1,055	199
8	Cleared ...	16	13	1,109	478	85
9	Bush ...	34	18	1,565	663	86

						1929.	1928.
Average weight (of bunches) per acre harvested from 5 Bush plots						2,704 lb.	1,410 lb.
"	"	"	"	"	bearing tree "	5	120 "
"	"	"	"	"	acre harvested "	4	2,531 "
"	"	"	"	"	bearing tree "	4	123 "
Average weight per bunch for Block						= 34 "	38 "

PALM PLOTS.

AREA OF BLOCK— $3\frac{1}{2}$ ACRES.AREA OF EACH PLOT— $\frac{1}{2}$ ACRE.

ORLU.

Plot.	Treatment.	Total No. of trees per plot (exclusive of planted seedlings.)	Total No. bearing trees per plot.	Total weight lb. bunches harvested per plot January-December.		Average weight lb. bunches harvested per bearing tree Jan.-Dec., 1929.
				1929.	1928.	
1	Bush ...	18	10	264	364	26
2	Cleared ...	36	31	1,040	783	33
3	Bush ...	16	14	725	524	51
4	Cleared ...	22	19	1,230	838	64
5	Bush ...	32	19	919	643	48
6	Cleared ...	22	14	501	718	35
7	Bush ...	31	19	353	576	18

						1929.	1928.
Average weight (of bunches) per acre harvested from 4 Bush plots						= 1,130 lb.	1,053 lb.
"	"	"	"	"	bearing tree "	4	36 "
"	"	"	"	"	acre harvested "	3	1,846 "
"	"	"	"	"	bearing tree "	3	43 "
Average weight per bunch for Block						= 15 "	24 "

ANNUAL REPORT, ILORIN PLANTATION, 1929.

Total area of experimental station = 297 acres.

Area under cultivation = 120 acres.

Latitude 8° 30 North, Longitude 4° 34 East.

Altitude 920 feet (Approx.)

Mean annual rainfall 1905-1929—51·05"

Distance from nearest point on coast = 146 miles.

The following officers were in charge for the period shown :—

H. G. Poynter, April 1st, 1929 to February 14th 1930.

P. W. T. Boughton-Leigh, February 14th, 1930 to March 1st, 1930.

The schemes for the old and new three-year rotations, for the purpose of maintaining soil fertility have been continued during the year. A test has been carried out, in order, to discover the most satisfactory time of year for digging in mucuna as a green manure. The same variety trials for cotton and groundnuts as in 1928 were repeated, that is Ishan cotton *versus* Ilorin native cotton, and in the case of groundnuts, Chinese *versus* Ilorin varieties.

The total rainfall for the year (*see* Table I) was above normal, being 56·88 inches, compared with the mean of twenty-five years, 51·05 inches. The rain was well distributed throughout the year, and was especially favourable for the early sown crops in late March and during April.

Similarly good conditions prevailed for the cotton planting season, but there was rather a prolonged drought during the short dry season, and this was the cause of a considerable incidence of bacterial disease, and the subsequent loss of plants was the result, after a good initial stand had been established.

As a matter of interest the following may be regarded as average yields per acre for this farm :—

(The figures represent an average yield for the various crops since 1923.)

Groundnuts	...	...	1,200 lb. per acre.
Maize	...	...	800 " " "
Guinea-corn	...	...	500 " " "
Yams	...	...	8,300 " " "
Cotton (Native)	...	...	140 " " "
Cotton (Ishan)	...	...	110 " " "
Rice (Creole) (av. for two years)			1,376 " " "

The following is a list of the average Market prices in Ilorin, for yams, maize, guinea-corn and groundnuts. The figures represent an average of the weekly price per cwt. in the Market throughout 1929 :—

Yams ...	...	...	2s. 5d. per cwt.
Maize ...	...	...	3s. 2d. " "
Guinea-corn	...	...	2s. 3d. " "
Groundnuts	...	...	4s. 10d. " "

FERTILITY EXPERIMENTS (TABLE II).

The first cycle of the old three-year rotation was completed. The cropping in 1926 on the three blocks was as follows :—

- A 1-20 Yams and Cotton.
- A 21-40 Maize and Guinea-corn.
- B 41-60 Mucuna.

The full results are given in Table II. but the following figures represent the yields per acre on A 1-20, and A 21-40 for 1926 and 1927. Mucuna was planted as a sole crop in accordance with the rotation scheme, on B 41-60 in 1929.

A 1-20

A 21-40

Yams '26.	Cotton '26.	Yams '29.	Cotton '29.	Maize '26.	G.-corn '26.	Maize '29.	G.-corn '29.
14,212	161	10,685	136 Ilorin.	1,454	601'	1,479	767

The same cycle of crops will be continued for 1930, so that A 1-20 goes in with mucuna, A 21-40 comes for yams and cotton, and B 41-60 will be planted with maize and guinea-corn.

From the table it will be seen that the yam crop in 1926 was higher than the 1929 crop. This is probably due to the fact that 1926 was a good year for yams and gave the highest average yield for any season on this farm since 1923. It is difficult to draw any definite conclusions on one cycle only, and future figures should show more conclusively whether there is an improvement or deterioration in the soil fertility.

The new three-year rotation which was commenced in 1929 is being continued on fifteen acres, divided into three blocks of five acres each. In this rotation there are five saleable crops grown with two short season mucuna crops, thus :—

First year—Yams and Cotton.

Second year—Groundnuts and Guinea-corn. Mucuna from September to March.

Third year—Maize. Mucuna from June to November.

The results of this rotation will be published at a later date.

The three series of the three-year rotations have been continued as laid down in 1924, and the figures will be given after the cropping in 1930. As the cropping was altered in 1924, the second cycle will not be completed in 1929 as was stated in the 1928 Bulletin, but in 1930.

FERTILITY EXPERIMENTS (continued).

(See Table III A and B.)

Mucuna buried during October v. Mucuna buried during March.

This experiment was carried out on Block A 41-60, the test crop being early maize (variety Lagos white). On the control plots the ridges were made over the cut green manure crop in October, on the treatments the mucuna was allowed to remain during the dry season and turned in as soon as the land was in a fit condition to be worked. During the dry season a good deal of self sown mucuna came up and it was necessary to weed the treatment plots twice.

The result of the experiment is not significant but the indication is that no advantage is gained by leaving the mucuna through the dry season. This result is similar to those obtained at Ibadan, by the same test. From the farmers' point of view, it is less expensive to dig in during November, when the land is easily worked, though it will be necessary to weed once or twice, to keep the ground free from weeds and self-sown mucuna.

Average of ten plots dug in in October = 1,320 lb. per acre (dry grain).

Average difference of nine plots dug in in March = -114 ± 118 lb. per acre.

Odds that the difference is significant 5 : 1.

FERTILITY EXPERIMENTS (continued).

Mucuna v. Weeds—Test crop early Maize (Table IV).

The cropping on E 2 1-9 was repeated this season, the mucuna planted in September 1928, being dug in for an early maize crop in 1929. Weeds which had grown on the even plots since the 1928 maize was harvested, were dug in at the same time.

Average of five plots following mucuna = 1,541 lb. dry grain per acre.

Average difference four plots following weeds = -411 ± 53 .

Odds that the difference is significant—over 10,000:1.

This cropping will be continued each year and the results published.

RESIDUAL EFFECT OF MUCUNA (TABLE V).

In 1927 the odd plots on block D 29–37 were under mucuna and the even plots allowed to grow weeds. All plots were ridged up for maize and guinea-corn in 1928 and the results (*see* Bulletin 1929) were as follows:—

Average combined dry grain of maize and guinea-corn on five plots after mucuna=1,310 lb. per acre.

Average difference on four plots after weeds= -412 ± 56 .

Odds that difference is significant=1,000:1.

Yams in November 1928 and cotton in July 1929 were planted throughout in order to test the residual effect, if any, from mucuna in 1927.

The results for the yam crop were as follows:—

Average of five plots of yams Boki after mucuna dug in 1927=11,875 lb. per acre.

Average difference four plots of yams after weeds dug in 1927= -802 ± 941 .

Odds that the difference is significant=4:1.

The results for the crop of cotton grown through the yams are as follows:—

Average of five plots after mucuna dug in 1927=185 lb. per acre.

Average difference of four plots after weeds dug in 1927= -16 ± 18 .

Odds that the difference is significant=4:1.

GROUNDNUT VARIETY TEST. (*See* Table VI).

A variety test was carried out on C 41–60, Chinese *versus* Ilorin. In the count for germination, Ilorin gave 98 *per cent.* and the Chinese variety gave 96 *per cent.* The Chinese commenced flowering at least a week before the Ilorin. On plot 41 in June there was a slight incidence of Resette disease, but as will be seen from the figures in the table, this was not serious. As in previous years, the Chinese was found to produce larger kernels, but not such a high yield as the Ilorin.

The actual results were as follows, worked out on a basis of dry undecorticated nuts per acre as in tests previously published.

Average of ten plots of Ilorin variety = 1,332 lb. per acre.

" difference of nine plots Chinese variety = -141 ± 44
lb. per acre.

Odds that the difference is significant = over 1,000 : 1.

This season, however, it was very noticeable that the percentage weight of kernels, in the Chinese variety, was considerably higher than the Ilorin, being 72 *per cent.* against 65 *per cent.* If this test is worked out on a basis of the yield per acre of kernels the result shows no appreciable difference between the two varieties.

The average of ten plots Ilorin being 866 lb. kernels per acre.

The average difference of nine plots Chinese being -8 ± 24 .

Odds that the difference is significant = 2 : 1.

These tests have been carried out in previous experiments (*see* Bulletin 1927-28), but in those years the difference in the kernel content was not so marked. The period between planting and harvesting is approximately a fortnight less in the case of Chinese. The nuts of this variety are considered of greater value.

COTTON.

Cotton has been grown in the old and new three-year rotation schemes and the results of the variety tests (Ilorin Native, *versus* Ishan A and B) carried out on these blocks are given in Tables (VII and VIII). In each case the Native cotton yielded better than either of the Ishans.

An experiment on topping plants on alternate plots on G 36-60 has been carried out. The plants were topped on August 24th-29th but the result is not significant—(For figures *see* Table IX.)

On D 29-37, Ishan A cotton was grown throughout the block, which had previously had mucuna on the alternate plots dug in, to test against weeds dug in at the same time on the other plots. The figures for this experiment are given in Table V, but the odds in favour of the mucuna are not more than 4 : 1.

LIMES.

The crop this year gave a higher yield than last year. Figures for the 1928 crop, as well as 1929 are given below. Yield given in lb. per acre.

Plots 21-24.		Plots 25-28.	
1928	25,998 lb.	1928	16,083 lb.
1929	28,485 „	1929	24,871 „

COCONUTS.

In April a few trees flowered, but in July the majority of nuts were shed soon after setting. The trees again flowered in October and November but the fruit did not mature.

ORCHARD.

Oranges, grape fruit and tangerines all yielded well and practically all the trees bore fruit.

Fifteen Julie mangoes have been propagated by in-arch grafting on to the indigenous stock.

Twenty oranges, eight grapefruit and six tangerines were successfully grafted on to lime stock.

RICE.

Multiplication plots of the varieties, Guiana Creole, Guiana seventy-five, and Maliya were again continued and seed distributed for trial in various districts. The rice this year was badly laid during heavy floods in September and this will possibly account for the inferior yield compared to 1928.

The yields of dry unhusked grain per acre were as follows for 1928 and 1929.

<i>Variety.</i>	<i>1928.</i>	<i>1929.</i>
Guiana Creole	1,900	832
„ “75”	1,442	738
Maliya	1,380	782

TABLE No. 1.
METEOROLOGICAL REPORT FOR 1929.
ILORIN FARM STATION.
Hour of observation, 9 a.m.

Months.		TEMPERATURE.							Relative humidity Sat. 100.	1929 rainfall in inches.	No. of days.	Average rainfall for 25 years.
		MEANS.		Range.	ABSOLUTE.							
		Max.	Min.		Max.	Date.	Min.	Date.				
January ...	...	95°	61°	34°	102°	8th ...	52°	14th ...	62	·89	1	·21
February ...	...	96°	61°	27°	100°	15th ...	55°	2nd ...	72	·56	1	·77
March ...	...	98°	71°	27°	100°	9th ...	66°	31st ...	75	4·65	3	2·06
April ...	...	92°	70°	22°	98°	4th ...	64°	17th ...	75	4·47	4	4·59
May ...	...	91°	71°	20°	96°	4th ...	67°	21st ...	74	4·35	9	6·86
June ...	...	87°	68°	19°	90°	4th ...	64°	26th ...	81	13·85	18	7·48
July ...	...	86°	69°	17°	88°	13th ...	66°	1st ...	83	4·84	11	5·77
August ...	...	84°	66°	18°	87°	19th ...	65°	15th ...	79	3·38	6	4·75
September ...	...	84°	69°	15°	88°	15th ...	68°	23rd ...	80	10·34	18	10·15
October ...	...	87°	69°	18°	91°	28th ...	67°	20th ...	79	7·43	12	6·59
November ...	...	90°	69°	21°	94°	23rd ...	59°	27th ...	77	2·12	2	1·46
December ...	...	90°	58°	32°	94°	5th ...	50°	26th ...	59	...	...	·35
Total ...	...	...	...	...	...	...	...	...	...	56·88	85	51·04

TABLE No. II.

THE CROPPING IN 1926 ON THE 3 PLOTS WAS AS FOLLOWS:—

A 1-20 YAMS AND COTTON.

A 21-40 MAIZE AND GUINEA-CORN.

B 41-60 MUCUNA.

This Cropping has been repeated in 1929, the results for the two years are as under.

Plot.	Yams and Cotton.				Plot.	Maize and Guinea-corn.			
	Y 1926	C.	Y 1929	C		M. 1926	G.c.	M. 1929	G.c.
1	14,400	133	9,408	160 Ilorin	21	1,000	488	916	429
2	12,320	132	10,304	128 Ishan A	22	1,348	456	1,151	561
3	11,040	95	8,064	80 Ilorin	23	1,116	460	886	497
4	10,720	143	9,072	144 Ishan B	24	1,160	232	910	452
5	21,640	185	10,864	144 Ilorin	25	1,348	668	1,386	617
6	10,880	185	10,640	172 Ishan A	26	1,720	228	1,634	803
7	8,128	116	10,304	147 Ilorin	27	1,612	812	1,699	875
8	11,120	132	11,088	144 Ishan B	28	1,660	772	1,403	892
9	13,440	189	10,864	140 Ilorin	29	1,508	816	1,656	977
10	12,992	162	11,984	116 Ishan A	30	1,512	564	1,617	861
11	15,904	182	11,312	148 Ilorin	31	1,564	876	1,666	969
12	15,008	162	11,200	92 Ishan B	32	1,676	304	1,436	845
13	14,896	205	11,536	111 Ilorin	33	1,424	716	1,649	875
14	15,232	183	12,096	92 Ishan A	34	1,316	704	1,464	879
15	16,532	238	11,200	160 Ilorin	35	1,392	680	1,842	754
16	18,592	135	10,752	76 Ishan B	36	1,372	592	1,724	803
17	16,464	153	10,528	112 Ilorin	37	1,436	784	1,768	784
18	17,536	164	11,649	72 Ishan A	38	1,952	328	1,535	786
19	18,032	182	10,864	120 Ilorin	39	1,456	780	1,653	767
20	18,368	171	9,968	176 Ilorin	40	1,516	772	1,577	829
				161					601
				136 { Ilorin					
				116 { Ishan A					
				114 { Ishan B					
Average	14,212		10,685			1,454		1,479	762

Maize, guinea-corn and cotton yields are very similar, there is a difference of only 25 *per cent.* in yam yield which may easily be caused by seasonal influence and not due to fertility. It is not possible to draw definite conclusions on one cycle of three years and this rotation will be continued for further periods and figures obtained for the rotation over several cycles of three years. There seems to be a fairly strong indication that for the first three years the fertility is at all events maintained whether there is a definite improvement will be seen after completion of further cycles.

TABLE No. IIIA.

EARLY MAIZE.—BLOCK A 41–60.

New Three-year Rotation—Maize and Mucuna.

Planting.—Variety Lagos white, 3rd April, 1929 6 ft. ridges 1 row of 2 plants per stand at 2 ft. intervals. 17½ lb. per acre.

Germination. Average for whole block 98%.

Supplying. April 12th 4½ lb. per acre.

Flowering. Commenced 20th May, 1929.

Harvesting. 1st and 2nd August, 1929.

Plots	Yields in dry grain per acre.	Plots.	Yields in dry grain per acre.
41	1,887	51	1,644
42	1,440	52	1,201
43	1,679	53	994
44	1,390	54	1,111
45	1,465	55	1,252
46	1,136	56	1,097
47	1,225	57	665
48	1,334	58	504
49	1,593	59	791
50	1,618	60	797

Average yield per acre as harvested	...	...	1,757 lb. per acre.
Average yield per acre dry cobs. ...	...	...	1,443 „ „ „
Percentage of grain on cob. ...	...	...	86%
Average number of cobs per stand	...	...	1·8
Average weight of dry cob ...	...	...	0·215 lb.
Average yield of dry grain per acre	...	...	1,241 lb.
Cost in man-days per acre ...	...	...	56 „
Value of crop per acre, current market price of 24 lb. at 6d.			£1 6s. 6d.
Cost of production at 10d. per man-day ...	...	...	£2 6s. 8d.

TABLE No. IIIB.

MUCUNA DUG IN OCTOBER *versus* MUCUNA DUG IN MARCH.

TEST CROP EARLY MAIZE. VARIETY LAGOS WHITE.

BLOCK A 41-60.

Plots.	Control, October.	Treatment, March.	Increase (+) or decrease (-) compared with mean of adjacent controls.
41	1,887		
42		1,440	- 343
43	1,679		
44		1,390	- 182
45	1,465		
46		1,136	- 209
47	1,225		
48		1,334	- 75
49	1,593		
50		1,618	- 1
51	1,644		
52		1,201	- 118
53	994		
54		1,111	- 12
55	1,252		
56		1,097	+ 137
57	667		
58		504	- 225
59	791		
60	797 Non Experimental.		
1,320			- 114

Yields given in dry grain per acre.

Root-mean-square-difference between neighbouring controls = 355.

Average of 10 plots dug in October 1,320 = lb. per acre.

Average difference of 9 plots dug in March = - 114±118 lb. per acre.

Odds that the difference is significant = 5 : 1.

Mucuna dug in on October 24th, 25th and March 23rd, 25th, 27th.

Maize variety Lagos white.

Planting.—Variety Lagos white. 3rd April, 1929, 6 feet ridges, 1 row of 2 plants
per stand at 2 feet intervals. $17\frac{3}{4}$ lb. per acre.

Germination.—Average for whole block = 98 per cent.

Supplying.—April 12th, $4\frac{1}{4}$ lb. per acre.

Flowering.—Commenced 20th May, 1929.

Harvesting.—1st August, 1929 and 2nd August, 1929.

		Controls.	Treatment.
Average yield per acre as harvested	...	1,862 lb.	1,710 lb.
„ „ dry cobs per acre	...	1,535 „	1,399 „
„ weight of „ „ stand	...	0.41 „	0.37 „
„ yield of dry grain per acre	...	1,320 „	1,203 „
Cost in man-days per acre	... ..	58 „	55 „

TABLE No. IV.

MAIZE FOLLOWING MUCUNA *versus* NO MUCUNA

DEMONSTRATION BLOCK E 2 1-9.

Plot.	Mucuna.	No Mucuna.	Increase (+) or decrease (-) compared with mean of adjacent controls.
1	1,511		
2		1,181	— 410
3	1,671		
4		1,080	— 522
5	1,530		
6		1,266	— 243
7	1,487		
8		1,028	— 470
9	1,508		
	1,541		— 411

Yields given in dry grain per acre.

Root—mean—square—difference of neighbouring controls = 109.

Average of 5 plots following Mucuna = 1,541 lb. per acre.

„ difference of 4 plots following no Mucuna = -411 ± 55 .

Odds that the difference is significant over 10,000 : 1.

Maize Variety.—Lagos white.

Planting.—April 9th, 6 feet ridges, 1 row, 2 plants per stand at 2 feet intervals
at the rate of $24\frac{1}{2}$ lb. per acre.

Germination—Average on all plots = 99%.

Supplying—April 20th.

Harvesting—August 3rd.

	Mucuna.	No Mucuna.
Average yield per acre as harvested ...	2,254 lb.	1,609 lb.
„ „ of dry cobs per acre ...	1,813 „	1,324 „
Percentage of grain on cob ...	85%	86%
Average number of cobs per stand ...	1.58	1.42
„ weight of dry cob ...	.31 lb.	.25 lb.
„ yield of dry grain per acre ...	1,541	1,139
Cost in man-days per acre including the Mucuna ...	60	41
Value of crop per acre, current market price 24 lb. at 6d. ...	£2 7s. 0d.	£1 13s. 6d.
Cost of production at 10d. per man-day ...	£2 10s. 0d.	£1 14s. 2d.

TABLE No. V.
 ISHAN A—COTTON AND YAMS.
 D 29-37. *MUCUNA* *versus* WEEDS.

Plots.	Control Ishan A.	Treatment Ishan A.	Increase (+) Decrease (-).	Control Yams.	Treatment Yams.	Increase (+) Decrease (-).
29	208			9,968		
30		184	- 30		9,632	- 1,848
31	220			12,992		
32		224	+ 8		12,992	0
33	212			12,992		
34		156	- 36		11,872	- 176
35	172			11,104		
36		136	- 6		10,528	- 1,184
37	112			12,320		
	924		- 64	59,376		- 3,208

Result given in lb. per acre.

Root—mean—square—difference of neighbouring controls = 37.

Average yield of 5 plots after *Mucuna* = 185

.. difference of 4 plots after weeds = -16 ± 18

Odds that the difference is significant = 4 : 1

Planting dates July 4th.

.. rates 8 lb. per acre.

Germination commenced 9th February, 1929, average stand = 93%

Supplying - 12th July, 1929 at 2 lb. per acre. 20th August, 1929 at 1 lb. per acre.

Harvesting - 28th January, 1930, 15th February, 1930, 25th March, 1930.

Cost in man-days per acre = 37

Root—mean—square—difference of neighbouring controls = 1,883

Yams.—Average of five plots of yams (*Boki*) after *Mucuna* dug in 1927 = 11,875 lb. per acre.

Average difference four plots of yams after weeds dug in 1927 = -802 ± 941

Odds that the difference is significant = 4 : 1

TABLE No. VI.
GROUNDNUT VARIETY TEST.—C41-60.
ILORIN *versus* CHINESE.

Plots.	Ilorin.	Chinese.	Increase (+) or decrease (-) compared with mean of adjacent controls.
41	1,260		
42		1,332	- 42
43	1,488		
44		1,196	-260
45	1,424		
46		1,168	-220
47	1,352		
48		1,112	-226
49	1,324		
50		1,112	-162
51	1,224		
52		1,160	...
53	1,096		
54		1,056	-148
55	1,312		
56		1,524	- 78
57	1,352		
58		1,288	-132
59	1,488		
60	Non-Experimental		
	1,332		- 141

Yields given in dry undecorticated nuts per acre.

Root—mean—square—difference—neighbouring controls = 131

Average of 10 plots of variety Ilorin = 1,332 lb. per acre

Average difference of 9 plots variety Chinese = -141±44 per acre

Odds that the difference is significant = over 1,000 : 1

Groundnuts planted March 21st and 22nd at the rate of 41 lb. per acre in 2 rows 1 foot apart on 6 feet ridges

Germination Ilorin = 98%. Chinese = 96%

Supplying—April 6th and 8th

Flowering—Chinese variety—16th April, 1929. Ilorin 26th April, 1929

Cost of production in man-days per acre = 86

Ilorin variety :

Percentage of dry undecorticated nuts to yield as harvested = 84%

“ “ “ “ “ “ “ rakings as “ “ = 63%

“ “ kernels in dry undecorticated nuts = 65%

Chinese variety :—

Percentage of dry undecorticated nuts to yield as harvested = 85%

“ “ “ “ “ “ “ rakings as “ “ = 64%

“ “ kernels in dry undecorticated nuts = 72%

TABLE VII.

BLOCK A 1-20 COTTON TRIAL IN OLD 3-YEAR ROTATION.

ILORIN NATIVE *versus* ISHAN A & B.

Plot.	Variety.	Yields in lb. per acre.		Increase (+) or decrease (-) compared with mean of adjacent controls.	
				Ishan A.	Ishan B.
Block					
1	Native	160			
2	Ishan A	128		+ 8	
3	Native	80			+ 32
4	Ishan B	144			
5	Native	144			
6	Ishan A	172		+ 27	
7	Native	147			
8	Ishan B	144			+ 1
9	Native	140			
10	Ishan A	116		- 28	
11	Native	148			
12	Ishan B	92			
13	Native	111			- 36
14	Ishan A	92		- 43	
15	Native	160			
16	Ishan B	76			- 60
17	Native	112			
18	Ishan A	72		- 44	
19	Native	120			
20	Native (Non-Experimental)	176			

Average 11 plots Native cotton = 132 lb. per acre.

,, difference 5 plots Ishan A = -16 ± 19 ,, ,,,, ,, 4 ,, ,, B = -16 ± 22 ,, ,,

Root—mean—square—difference between neighbouring controls = 43.

Odds that the difference is significant for A = 4 : 1.

,, ,, ,, ,, ,, ,, ,, B = 2 : 1.

Area of plots = $\frac{1}{4}$ acre.

Cotton planted 2nd July, 1929.

,, harvested 14th and 25th January. 5th, 14th and 22nd February.

Percentage clean = 87.

Cost in man-days per acre = 26.

TABLE VIII.

COTTON TRIAL IN NEW YEAR ROTATION ILORIN NATIVE
versus ISHAN A AND B.

BLOCK C 1-20.

Plot.	Variety.	Yield in lb. per acre.		Increase (+) or decrease (-) compared with mean of adjacent controls.	
				Ishan A.	Ishan B.
1	Native	108			
2	Ishan A	92		- 32	
3	Native	140			
4	Ishan B	120			- 8
5	Native	116			
6	Ishan A	112		- 2	
7	Native	112			
8	Ishan B	88			- 6
9	Native	76			
10	Ishan A	100		- 24	
11	Native	172			
12	Ishan B	84			- 64
13	Native	124			
14	Ishan A	96		- 40	
15	Native	148			
16	Ishan B	124			- 24
17	Native	148			
18	Ishan A	92		- 42	
19	Native	120			
20	Native (Non-Experimental)	144			

Average 11 plots Native = 126 lb. per acre.

„ difference 5 plots Ishan A = $- 28 \pm 18$ lb. per acre.

„ „ 4 „ „ B = $- 25 \pm 21$ „ „ „

Root—mean—square—difference between neighbouring controls = 42.

Odds that the difference is significant for A = 17 : 1.

„ „ „ „ „ „ „ B 9 : 1.

$\frac{1}{4}$ acre plots.

Cotton planted on 1st July, 1929.

Harvest dates—January 14th and 24th. February 4th, 13th and 21st.

March 9th.

Cost in man-days per acre = 25.

Percentage clean = 92.

TABLE No. IX.

COTTON BLOCK G 36-60.

PLANTS TOPPED ON AUGUST 24TH, 1929,
versus PLANTS UNTOPPED.

Plot.	Control Plants untopped.	Treatment Plants topped.	Increase (+) or decrease (-) compared with mean of adjacent controls.
36	113		
37		133	- 23
38	199		
39		215	+ 3
40	226		
41		251	+ 31
42	215		
43		224	+ 29
44	176		
45		126	- 46
46	168		
47		203	+ 14
48	210		
49		241	+ 35
50	203		
51		203	1
52	202		
53		192	- 19
54	220		
55		180	- 26
56	193		
57		156	- 29
58	177		
59		175	+ 14
60	146		
	2,448		- 16

RESULT—Yield given in lb. per acre.

Root—mean—square—difference of neighbouring controls = 34 lb.

Average yield 13 plots untopped = 188.

,, difference 12 plots topped = - 1 ± 10 .

Odds that the difference is significant = less than 2 : 1.

Planting date—July 4th.

,, rates—10 lb. per acre.

Germination—commenced 9th August, 1929. Average stand count = 97%.

Supplying on 12th July, 1929 at 2 lb. 20th August, 1929 at $\frac{1}{2}$ lb. per acre.

Date of topping—24th August, 1929.

Harvesting 9th, 17th, 18th, 20th, 27th January and 6th and 18th February.

Cost in man-days per acre = 55.

Percentage clean = 96.03.

ANNUAL BULLETIN REPORT, 1929, SAMARU AGRICULTURAL STATION.

The following Officers were in charge of the Station during the year :—

Mr. O. S. Swainson from 1st January, 1929 to 9th June, 1929

„ E. W. Leach „ 10th June, 1929 „ 31st Dec., 1929.

The year under review marks a further stage in the progress of mixed farming, for, with the exception of six and a half acres the whole farm was worked by cattle-drawn implements, and in a difficult season, with an abnormal rainfall, the results obtained are distinctly encouraging.

The amount of work which can be done by a pair of cattle on the comparatively heavy soil at Samaru is limited by two factors, both of which were experienced this year, namely, the late arrival of the rains and heavy mid-season rains. The lateness of the early rain hindered the work of preparation of the land for the corn crops, and the heavy rains in August caused such severe water-logging of the soil that cultivation became impossible and had to be postponed until the land became drier. In spite of this, the amount of manual Labour necessary for crop production has been considerably reduced. (*See Table No. 10*).

Implements.—Continual alterations have been made in the locally-made implements and by the end of the season a much improved plough was evolved which was both easily adjustable and rode flat on its sole. Fresh types of implements were also evolved including a plough especially adapted for the lifting of groundnuts and a dry season cultivator which scrapes the ridges and helps to prevent the weeds from seeding, but while it is useful to have a variety of implements for special purposes, they are by no means essential to the native cultivator, since practically all the work can be done by the plough and the ordinary cultivator.

Cattle Cultivation Farmers.—Two native farmers in the vicinity of Samaru have now completed a year's trial of mixed farming. They each possess two working bulls, one heifer, and the necessary implements, and are rapidly adapting their farming to the new conditions. They have enlarged their farms considerably and the crop yields obtained were well up to the average for the district.

A third farmer has expressed a wish to take up mixed farming and he will commence cattle cultivation this coming season.

Imported Beans.—As previously, little success was obtained from these beans. Interplanted in gero the following results were obtained as compared to local cowpeas.

Large seeded Lima	...	...	136 lb. per acre in the pod.
Small seeded Lima	...	...	59.6 " " " " " "
Yellow seeded Soya bean	...	...	78 " " " " " "
Black seeded Soya bean	...	...	38 " " " " " "
Speckled Lima	...	...	82 " " " " " "

Nigerian selected cowpeas interplanted in maize, which was cut for silage, yielded at the rate of 126 lb. per acre.

It is possible that the failure of many of these beans is due to the fact that the particular organism necessary for nitrogen assimilation by any one variety is not present in the soil. It is proposed next year to try the effect of inoculation and a start will be made with the Soya beans.

Farm-yard Manure.—It appears from this year's manurial experiments that it is economically sound to apply small rates of manure of one, two and three tons per acre to guinea-corn (See Table No. 3).

Rainfall and Weather.—This season was marked by very heavy rainfall which, in addition, was not normally distributed. After the first rains at the end of March which were too light for planting, there was a drought lasting thirty-six days which seriously delayed the sowing of the grain crops. Heavy mid-season rains were then experienced in July, August and September which resulted in much "wash" and waterlogging.

FARMYARD MANURE ON COTTON EXPERIMENT.

See Table No. 2.

	Yield seed cotton in lb. per acre.	Odds that difference is significant.
1928.		
Average yield 7 plots with no manure	314	—
Average difference 6 plots with 1 ton Farm- yard Manure per acre	+ 18.7±31.4	—
1929.		
Average yield 7 plots with no manure	244.9	—
Average difference 6 plots with 1 ton Farm- yard Manure per acre	+ 59.8±28.9	50 : 1

The yields from both manured and unmanured plots were less than last season, as owing to waterlogging cotton on our farm was this year a comparatively poor crop. The difference due to the effect of the manure, although the dressing is only one ton per acre, was however very much greater and could be easily detected by eye. Cotton has now been grown on this block continuously since

1925, during which time the odd plots have never been manured, and the even plots were first manured in 1928. Previously the unmanured plots gave slightly the higher yield.

GUINEA-CORN—RATE OF MANURING EXPERIMENT.

See Table No. 3.

	Yield of guinea-corn in lb. grain per acre.	Odds that difference is significant.
Average yield 13 plots with no manure ...	212·6	—
Average difference 4 plots with 1 ton Farm-yard Manure	+ 159·5 ± 52·8	740 : 1
Average difference 4 plots with 2 tons Farm-yard Manure	+ 275·3 ± 52·8	Over 100,000 : 1
Average difference 4 plots with 3 tons Farm-yard Manure	+ 385·6 ± 52·8	Over 100,000 : 1

The Chemist took weekly soil samples from the plots in this experiment to trace the loss, or otherwise, of nitrates.

The results are extremely significant in that such large increases are obtained from such small rates of application. The incremental yields obtained for each ton applied are:—

1st ton	... ..	159·5 lb.
2nd „	... ..	115·8 „
3rd „	... ..	110·3 „

A dressing of one ton of farm-yard manure per acre is very small compared with English standards of application but in this case it has given a 75% increase in yield over the unmanured plots.

GUINEA-CORN—SUPERPHOSPHATE *v* NIGERIAN ROCK PHOSPHATE.

See Table No. 4.

1927—MANURES APPLIED.

	Lb. per acre 'one day dried' mucuna.	Odds that difference is significant.
Average yield 10 plots 200 lb. Nigerian Rock Phosphate per acre	2,328·0	—
Average difference 9 plots 220 lb. Superphosphate per acre	+ 1,229·8 ± 128·7	α : 1

1928—1ST YEAR RESIDUAL EFFECT.

1929—2ND YEAR RESIDUAL EFFECT.

	Lb. per acre guinea-corn grain.	Odds that difference is significant.	Lb. per acre guinea-corn grain.	Odds that difference is significant.
Average yield 10 plots 200 lb. Nigerian Rock Phosphate per acre	820	—	263·4	—
Average difference 9 plots 220 lb. Superphosphate per acre	+ 52 ± 71	3 : 1	+ 20 ± 18·9	6 : 1

Although the yields of guinea-corn are very low in the second year of the residual effect, the Nigerian rock phosphate plots do, for the first time, show a slight increase over those dressed with super-phosphate.

This is probably due to the fact that the residual effect of the readily available superphosphate has become exhausted and that the phosphate in the Nigerian rock phosphate may still be in the process of becoming slowly available.

GUINEA-CORN—SPACING TEST.

See Table No. 5.

	Yield of guinea-corn in lb. grain per acre.	Odds that difference is significant.
Average yield 16 plots with plants 4' apart	407	—
Average difference 8 plots with plants 3' apart	- 5 ± 31.5	—
Average difference 7 plots with plants 5' apart	- 15 ± 33.7	10 : 1

There is no significant difference in yield between the three feet and four feet spacing but the experiment does indicate that when guinea-corn is planted at a wider spacing than four feet there is a resultant loss of grain. This confirms the result of a similar experiment conducted last year with four, five and six feet spacing. The standard spacing for guinea-corn on the two feet six inch ridge has been four feet but in view of the above results it may prove advantageous to adopt three feet spacing as, although there is no change in the amount of grain, there is an increase in the amount of fodder obtained.

GROUNDNUTS—VARIETY AND DATE OF PLANTING TEST.

See Table No. 6.

	Yield of ground-nuts in lb. decorticated nuts per acre.	Odds that difference is significant.
Average yield 16 plots Zaria Maiyado sown June 5th	469.7	—
Average difference 5 plots Mache Atsugane sown June 5th	+ 63.2 ± 23.4	287 : 1
Average difference 5 plots Mache Atsugane sown May 20th	- 134.8 ± 23.4	Over 100,000 : 1
Average difference 5 plots, Zaria Maiyado sown, May 20th	— 103.1 ± 23.4	Over 100,000 : 1

It was thought that by planting groundnuts earlier, they would mature earlier, and could thus be harvested before the soil dried out and became difficult to work. But no difference was noticeable in the state of maturity of the nuts and accordingly all plots were harvested at the same time.

The fact that both varieties show a significant decrease in yield when sown on the earlier date is surprising and it would seem that the optimum period of growth during the wet season is definitely limited.

Mache Atsugane sown on June 5th gave a significant increase in yield over Zaria Maiyado sown on the same date. On the earlier dates the reverse obtained but the difference was not so marked.

Mache Atsugane has an upright habit of growth whereas Zaria Maiyado is creeping, and this characteristic enables it to be cultivated by cattle-drawn implements at any time (during its growth) without any harm being done to the plant.

With Zaria Maiyado, the final ridging has of necessity to be done by hand as otherwise the plough would break away or damage the greater proportion of its prostrate branches.

At harvesting Mache Atsugane is easily turned out of the ground by the plough but with Zaria Maiyado the plant drags and consequently nuts are left in the soil.

Thus, the indications are that Mache Atsugane is the better variety for use under mixed farming conditions, especially as, over and above the smaller cost of production, it shows a significant increase in yield when planted at the normal time.

GUINEA-CORN—WIDTH OF RIDGES EXPERIMENT.

See Table No. 7.

	Yield of guinea-corn lb. grain per acre.	Odds that difference is significant.
Average yield 9 plots with 4' ridges	472	—
Average difference 8 plots with 2' 6" ridges —	4.75 ± 68.25	—

This crop suffered somewhat from the heavy rains but the plants on the wider and larger ridges were not affected so much by temporary waterlogging as were those on the smaller ridge. In spite of this the difference in yield is negligible.

Thus, all other things being equal, the change to two feet six inch ridges for cattle cultivation purposes does not significantly affect the yield as far as guinea-corn is concerned.

This does not bear out the result obtained from a similar experiment conducted last year when the figures obtained were as follows:—

	Loss of threshed grain per acre.	Odds that difference is significant.
Average yield of 9 plots guinea-corn on 4' ridges... ..	953	—
Average difference of 8 plots guinea- corn on 2' 6" ridges	— 118 ± 50	510 : 1

GUINEA-CORN—FARMYARD MANURE v KRAALING EXPERIMENT—

RESIDUAL EFFECT *see* Table No. 8.

	Yield of guinea-corn in lb. grain per acre.	Odds that difference is significant.
Average yield 17 plots after 400 C.Ns. Kraaled per acre	513.7	—
Average difference 4 plots after 100 C.Ns. Farmyard Manure per acre	— 208.3 $\pm$ 55.2	11,110 : 1
Average difference 4 plots after 200 C.Ns. Farmyard Manure per acre	— 13.3 $\pm$ 55.2	—
Average difference 4 plots after 300 C.Ns. Farmyard Manure per acre	+ 89.5 $\pm$ 55.2	18 : 1
Average difference 4 plots after 400 C.Ns. Farmyard Manure per acre	+ 199 $\pm$ 55.2	5,535 : 1

The superiority of land dressed with farmyard manure over that treated by the native method of kraaling is still maintained to a significant extent in their respective residual effects.

The plots were manured in 1928 and the results obtained then from a testing crop of cotton were:—

	Yield in lb. seed cotton per acre.	Odds that difference is significant.
400 C.Ns. Kraaled per acre	329	—
100 C.Ns. Farmyard Manure per acre	— 50 $\pm$ 17	78,000 : 1
200 C.Ns. Farmyard Manure per acre	— 29 $\pm$ 17	22 : 1
300 C.Ns. Farmyard Manure per acre	+ 22 $\pm$ 17	9 : 1
400 C.Ns. Farmyard Manure per acre	+ 73 $\pm$ 17	33,300 : 1

This experiment is an exact repetition of one conducted in 1926 and 1927 a full report of which was given in the Seventh Annual Bulletin of this Department.

The conclusion then drawn was "That 200 cattle nights of farmyard manure are approximately the equivalent of 400 cattle nights of kraaling" and the results now obtained confirm this.

COTTON STRAIN TEST.

See Table No. 9.

	Lb. of seed cotton per acre.	Odds that difference is significant.
Average yield 15 plots Zaria Ginnery Seed	147.7	—
Average difference 7 plots Strain D	+ 24.8 $\pm$ 18.3	11 : 1
Average difference 7 plots Strain G	— 28.1 $\pm$ 18.3	15 : 1

The yields obtained are poor but this is due entirely to the low state of fertility of the block. The results, although not significant, show that strain D is at least the equal of the Zaria standard ginnery grade I seed in regard to yield.

Strain G was comparatively late in coming into full maturity and there is an indication that it is slightly inferior in yield. The lint from Strains D and G was superior to the standard being both longer and less harsh.

Grasses.—Work continues on fodder grasses and this year plots of Iburu (*Digitaria iburia*), Acha (*Digitaria exilis*), Gadagi, (*Alysicarpus vaginalis*) and Tamba—(*Eleusine corocana*) have been laid down on an experimental basis to compare their qualities with the natural indigenous grassland both from the point of view of grazing and of the making of hay.

The experiment was not established early enough for any results to be obtained this year as many of the natural grasses had already matured and become coarse, and the germination of some of the pure grasses was not all that could be desired.

Accordingly, those plots intended for hay were allowed to seed and the following yields were obtained:—

				Lb. per acre. as cut.	Lb. per acre straw after threshing.	Lb. per acre of seed.
Iburu	...	...	...	3,412	1,872	356
Acha	...	...	...	2,428	1,476	296
Tamba	...	...	...	1,332	544	82
Gadagi	...	...	...	Failure	—	—

CATTLE. See Table Nos. 12 and 13.

The general health of the stock has been maintained throughout the year with the exception of the recurrence of *Streptothricosis* (Hausa—Kirchi). In spite of regular spraying with an arsenical solution some dozen beasts were affected. Two fresh treatments were tried:—

- (i) Dressing with copper sulphate paste.
- (ii) Applying a five per cent. solution of sodium hyposulphate which is immediately followed by an application of a five per cent. acetic acid.

These remedies were efficacious where the attack was light but had little effect otherwise.

At the end of the dry season, five cows are still suffering from severe attacks of this disease.

Completed lactations from the Shuwa herd are given in Table No. 13. It will be noted that three cows have exceeded 3,000 lb., the best yield being that of cow No. 26 who gave 3,432 $\frac{3}{4}$ lb. in 365 days.

Regular sampling and testing of milk for butter-fat content has been instituted but no figures are yet to hand for a completed lactation.

Four bull calves and nine heifer calves of known parentage have been transferred to the breeding herd during the year. The rate of natural increase of the herd for the last two years has been as follows:—

1928 (January to December)	...	...	—	3.1%
1929 „ „ „ „ „ „	...	...	...	+16.1%

No trouble has been experienced with the working cattle and during the wet season they were able to work on the land on 120 days. This figure was limited by the waterlogging on many parts of the farm during the heavy mid-season rains.

Four cows have recently been ringed for work and are at present being trained.

Poultry.—The Rhode Island Red is the only breed now kept at Samaru. No birds were sold during the year as an effort is now being made to increase the stock.

Records for the birds for the year are:—

Stock on 1st April, 1929	...	8	
Bred during the year	...	42	
Purchases	...	4	54
Sold during the year	...	—	
Died during the year	...	16	16
Stock on 31st March, 1930	...	—	38

TABLE No. 1.
RAINFALL—SAMARU, 1929.

Month.					Inches of rain.	Number of days on which rain fell.	Average rainfall at Samaru, 1924-28 inclusive.
January	...	...	...	...	...	...	...
February	...	...	...	...	...	...	(0.02 fell in 1928).
March	...	...	...	...	0.50	2	0.89
April	...	...	...	...	0.06	1	1.59
May	...	...	...	...	6.87	11	4.38
June	...	...	...	...	5.80	17	7.85
July	...	...	...	...	10.98	20	10.07
August	...	...	...	...	14.26	25	11.54
September	...	...	...	...	9.97	18	8.96
October	...	...	...	...	2.50	6	2.18
November	...	...	...	...	...	...	0.08
December	...	...	...	...	...	...	...
Totals					50.94	100	47.54

TABLE No. 2.

FARMYARD MANURE ON COTTON EXPERIMENT.

Plot.	Treatment.	Yield of seed cotton in Pounds per acre.	Increase (+) or decrease (-) compared with mean of adjacent controls.
A 1	No Manure	104	
2	1 ton F. Y. M. per acre	232	+ 75
3	No Manure	210	
4	1 ton F. Y. M. per acre	280	+ 55
5	No Manure	240	
6	1 ton F. Y. M. per acre	258	+ 29
7	No Manure	218	
8	1 ton F. Y. M. per acre	352	+ 71
9	No Manure	344	
10	1 ton F. Y. M. per acre	384	+ 58
11	No Manure	308	
12	1 ton F. Y. M. per acre	370	+ 71
13	No Manure	290	

Variety :— Allen Cotton.

Each plot $\frac{1}{4}$ acre.
Sown July 1st, 1929.

Ridges two feet six inches apart.
Harvested—January 14th, 1930.
February 11th and 26th 1930.

Increase (+) or Decrease (-) of 6 plots
with 1 ton F. Y. M. per acre compared
with those no manure.

+	75	lb	per	acre.
+	55	"	"	"
+	29	"	"	"
+	71	"	"	"
+	58	"	"	"
+	71	"	"	"

Average + 59.8 + 28.9 lb per acre.

Root-mean-square-difference between pairs of neighbouring controls = 70.8.

Cost of cultivation :—	{	Man-days	= 41·2.
	{	Cattle-days	= 17·2.

TABLE No. 3.

RATE OF APPLICATION OF F. Y. M. EXPERIMENT.

Plot.	Treatment.				Yield in lb. of grain per acre.		Increase(+) or decrease(-) compared with mean of adjacent controls.
A 41	No Manure	...	...	...	95		
42	1 ton F. Y. M.	...	...	...	263		+ 133
43	No Manure	...	...	...	165		
44	2 tons F. Y. M.	...	...	...	417		+ 158
45	No Manure	...	...	...	353		
46	3 tons F. Y. M.	...	...	...	580		+ 246½
47	No Manure	...	...	...	314		
48	1 ton F. Y. M.	...	...	...	418		+ 154
49	No Manure	...	...	...	218		
50	2 tons F. Y. M.	...	...	...	557		+ 357
51	No Manure	...	...	...	182		
52	3 tons F. Y. M.	...	...	...	470		+ 326
53	No Manure	...	...	...	106		
54	1 ton F. Y. M.	...	...	...	344		+ 154
55	No Manure	...	...	...	274		
56	2 tons F. Y. M.	...	...	...	473		+ 248½
57	No Manure	...	...	...	175		
58	3 tons F. Y. M.	...	...	...	591		+ 390
59	No Manure	...	...	...	227		
60	1 ton F. Y. M.	...	...	...	470		+ 197
61	No Manure	...	...	...	319		
62	2 tons F. Y. M.	...	...	...	616		+ 337½
63	No Manure	...	...	...	238		
64	3 tons F. Y. M.	...	...	...	748		+ 580
65	No Manure	...	...	...	98		

Variety sown :—Guinea-corn—Farafara.
Each plot ¼ acre.
Sown 16th May, 1929.

Increase (+) or Decrease (-) of 4 plots
with 1 ton F. Y. M. per acre compared
with those with no manure.
+ 133 lb. per acre.
+ 154 " " "
+ 154 " " "
+ 197 " " "

Average + 159.5 ± 52.8 lb per acre.

Ridged 2 feet 6 inches apart.
Harvested 7th December, 1929.

Increase (+) or Decrease (-) of 4 plots
with two tons F. Y. M. per acre compared
with those with no manure.
+ 158 lb per acre.
+ 357 " " "
+ 248.5 " " "
+ 337.5 " " "

Average + 275.3 ± 52.8 lb per acre.

Increase (+) or Decrease (-) of 4 plots
with 3 tons F. Y. M. per acre compared
with those with no manure.
+ 246.5 lb. per acre.
+ 326 " " "
+ 390 " " "
+ 580 " " "

Average + 385.6 ± 52.8 lb per acre.

Root—mean—square—difference between pairs of neighbouring control plots = 105.56.

Cost of cultivation:— { Man-days = 40.
 { Cattle-days = 3.

TABLE No. 4.

SUPERPHOSPHATE AND NIGERIAN ROCK PHOSPHATE—2ND YEAR
RESIDUAL EFFECT.

Plot.	Treatment.				Yield in lb. of grain per acre.		Increase (+) or decrease (–) compared with mean of adjacent controls.
A 92	25	lb.	N. R. P. ...	...	244		
92A	27·5	"	Superphosphate ...	...		256	+ 11
93	25	"	N. R. P. ...	...	246		
93A	27·5	"	Superphosphate ...	...		288	+ 1
94	25	"	N. R. P. ...	...	328		
94A	27·5	"	Superphosphate ...	...		276	– 46
95	25	"	N. R. P. ...	...	316		
95A	27·5	"	Superphosphate ...	...		264	– 52
96	25	"	N. R. P. ...	...	316		
96A	27·5	"	Superphosphate ...	...		310	– 19
97	25	"	N. R. P. ...	...	342		
97A	27·5	"	Superphosphate ...	...		260	– 31
98	25	"	N. R. P. ...	...	240		
98A	27·5	"	Superphosphate ...	...		282	+ 38
99	25	"	N. R. P. ...	...	248		
99A	27·5	"	Superphosphate ...	...		178	– 23
100	25	"	N. R. P. ...	...	154		
100A	27·5	"	Superphosphate ...	...		118	– 59
101	25	"	N. R. P. ...	...	200		
101A	25	"	N. R. P. ...	...	106		

Variety sown: — Guinea-corn—Farafara.

Each plot $\frac{1}{8}$ th acre. Ridges 4 feet apart.

Manures applied in 1927.

Sown 16th May, 1929.

Harvested 11th December, 1929.

Increase (+) or Decrease (–) of 9 plots
with 27·5 lb Super. compared with those
with 25 lb N. R. P.

+ 11 lb per acre.

+ 1 " " "

– 46 " " "

– 52 " " "

– 19 " " "

– 31 " " "

+ 38 " " "

– 23 " " "

– 59 " " "

Average – 20 ± 18·9 lb per acre.

Root—mean –square –difference between pairs of neighbouring control plots
56·7.

Cost of cultivation in man-days per acre = 58·9.

TABLE No. 5.

CATTLE CULTIVATION ROTATION—GUINEA-CORN.
SPACING EXPERIMENT.

Plot.	Treatment.	Yield in lb. of grain per acre.	Increase (+) or decrease (-) compared with mean of adjacent controls.
C35	Spaced 4' apart	697	
36	" 3' "	616	- 37
37	" 4' "	610	
38	" 5' "	459	- 90
39	" 4' "	487	
40	" 3' "	417	- 61
41	" 4' "	470	
42	" 5' "	454	- 13
43	" 4' "	465	
44	" 3' "	512	+ 53
45	" 4' "	453	
46	" 5' "	350	- 101
47	" 4' "	448	
48	" 3' "	378	- 24
49	" 4' "	356	
50	" 5' "	280	- 50
51	" 4' "	305	
52	" 3' "	204	- 57
53	" 4' "	218	
54	" 5' "	339	+ 34
55	" 4' "	392	
56	" 3' "	328	+ 9
57	" 4' "	246	
58	" 5' "	232	- 60
59	" 4' "	339	
60	" 3' "	412	+ 90
61	" 4' "	305	
62	" 5' "	266	- 35
63	" 4' "	297	
64	" 3' "	347	- 13
65	" 4' "	423	
66	" 4' "	405	Non-experimental.

Variety sown:— Guinea-corn—Farafara.
Each plot $\frac{1}{4}$ acre.
Sown 21st May, 1929.

Ridges 2' 6'' apart.
Harvested 6th December, 1929.

Increase (+) or Decrease (-) of 8 plots
with plants spaced at 3' compared
with those at 4'
- 37 lb per acre.

- 61	"	"	"
- 53	"	"	"
- 24	"	"	"
- 57	"	"	"
+ 9	"	"	"
+ 90	"	"	"
- 13	"	"	"

Increase (+) or Decrease (-) of 7 plots
with plants spaced at 5' compared
with those at 4'

-	90
-	13
-	101
-	50
+	34
-	60
-	35

Average = 5 ± 31.5 lb per acre.

Average = 45 ± 33.7 lb per acre.

Root-mean-square-difference between pairs of neighbouring controls = 89·1
 Cost of cultivation:— { Man-days per acre = 22.
 Cattle-days „ „ = 7.

TABLE No. 6.

CATTLE CULTIVATION ROTATION—GROUNDNUTS. VARIETY
AND DATE OF PLANTING TEST.

Plot.	Treatment.	Yield in lb of decorticated nuts per acre.	Increase (+) or de- crease (—) compared with mean of adjacent controls.
C 69	Zaria Maiyado June 5th	426	
70	Mache Atsugane " "	524	+ 131
71	Zaria Maiyado June 5th	360	
72	" " May 20th	395	— 8
73	" " June 5th	446	
74	Mache Atsugane May 20th	408	— 57
75	Zaria Maiyado June 5th	484	
76	Mache Atsugane June 5th	519	+ 43·5
77	Zaria Maiyado June 5th	475	
78	" " May 20th	302	— 178
79	" " June 5th	485	
80	Mache Atsugane May 20th	316	— 145·5
81	Zaria Maiyado June 5th	438	
82	Mache Atsugane June 5th	526	+ 46·5
83	Zaria Maiyado June 5th	521	
84	" " May 20th	480	— 36·5
85	" " June 5th	512	
86	Mache Atsugane May 20th	362	— 103
87	Zaria Maiyado June 5th	418	
88	Mache Atsugane June 5th	567	+ 145
89	Zaria Maiyado June 5th	426	
90	" " May 20th	402	— 47
91	Zaria Maiyado June 5th	472	
92	Mache Atsugane May 20th	349	— 140·5
93	Zaria Maiyado June 5th	507	
94	Mache Atsugane June 5th	439	— 50
95	Zaria Maiyado June 5th	471	
96	" " May 20th	343	— 146
97	" " June 5th	507	
98	Mache Atsugane May 20th	309	— 228
99	Zaria Maiyado June 5th	567	
100	" " " " " "	516	Non-experimental

Variety sown:— Groundnuts—Zaria Maiyado
Mache Atsugane.

Each plot $\frac{1}{4}$ acre.

Spaced 1' apart on 2' 6" ridges.

Sown 20th May and 5th June.

Harvested 11th November, 1929.

Increase (+) or Decrease (—) of 5 plots
Mache Atsugane sown June 5th compared
with Zaria Maiyado sown June 5th.

+ 131 lb per acre.
+ 43·5 " " "
+ 46·5 " " "
+ 115 " " "
— 50 " " "

Increase (+) or Decrease (—) of 5 plots
Mache Atsugane sown May 20th compared
with Zaria Maiyado sown June 5th.

— 57 lb per acre.
— 145·5 " " "
— 103 " " "
— 140·5 " " "
— 228 " " "

Average + 63·2 $\pm$ 23·4 lb per acre.

Average — 134·8 $\pm$ 23·4 lb per acre.

TABLE No. 6—*continued*.

Increase (+) or Decrease (–) of 5 plots
Zaria Maiyado sown May 20th compared
with Zaria Maiyado sown June 5th.

–	8	lb	per	acre.
–	178	"	"	"
–	36.5	"	"	"
–	47	"	"	"
–	146	"	"	"

Average = 103.1 ± 23.4 lb per acre.

Root—mean—square—difference between pairs of neighbouring control plots = 52.3.

Cost of cultivation:— { Man-days per acre = 79.8.
Cattle-days per acre = 6.8.

TABLE 7.

WIDTH OF RIDGES EXPERIMENT.

Plot.	Treatment.	Yield in lb of grain per acre.		Increase (+) or decrease (–) compared with mean of adjacent controls.
D 50	Ridges 4' apart...	572		
51	" 2' 6" " ...		364	– 76
52	" 4' " ...	308		
53	" 2' 6" " ...		356	– 61
54	" 4' " ...	526		
55	" 2' 6" " ...		568	+ 88
56	" 4' " ...	434		
57	" 2' 6" " ...		614	+ 17
58	" 4' " ...	760		
59	" 2' 6" " ...		644	– 30
60	" 4' " ...	588		
61	" 2' 6" " ...		447	– 72
62	" 4' " ...	450		
63	" 2' 6" " ...		474	+ 76
64	" 4' " ...	346		
65	" 2' 6" " ...		325	+ 20
66	" 4' " ...	264		

Variety sown:—Guinea-corn—Kaura.

Each plot $\frac{1}{4}$ acre.

Sown 17th May, 1929.

Spaced 3' apart on both 4' and 2' 6" ridges.

Harvested 6th December, 1929

Increase (+) or Decrease (–) of plots
with 2' 6" ridges compared with
those with 4' ridges.

–	76
–	61
+	88
+	17
–	30
–	72
+	76
+	20

Average = 4.75 ± 68.25 lb per acre.

Root—mean—square—difference between pairs of neighbouring control plots = 193.

Cost of cultivation in man-days per acre = 37.5

TABLE No. 8.

FARM-YARD MANURE *versus* KRAALING EXPERIMENT.—RESIDUAL EFFECT.

Plot.	Treatment.	Yield in lb. of grain per acre.		Increase (+) or decrease (—) compared with mean of adjacent controls.
E. 34	400 Cattle Nights Kraaling	474		
35	100 " " F.Y.M.	352		— 202
36	400 " " Kraaled	634		
37	200 " " F.Y.M.	567		— 85
38	400 " " Kraaled	670		
39	300 " " F.Y.M.	719		— 63·5
40	400 " " Kraaled	641		
41	400 " " F.Y.M.	729		+ 41·5
42	400 " " Kraaled	734		
43	100 " " F.Y.M.	343		— 356·5
44	400 " " Kraaled	667		
45	200 " " F.Y.M.	574		+ 9·5
46	400 " " Kraaled	462		
47	300 " " F.Y.M.	498		+ 114·5
48	400 " " Kraaled	305		
49	400 " " F.Y.M.	621		+ 290·5
50	400 " " Kraaled	56		
51	100 " " F.Y.M.	276		— 145
52	400 " " Kraaled			
53	200 " " F.Y.M.	483		— 14·5
54	400 " " Kraaled	509		
55	300 " " F.Y.M.	599		— 157·5
56	400 " " Kraaled	374		
57	400 " " F.Y.M.	524		+ 165·5
58	400 " " Kraaled	343		
59	100 " " F.Y.M.	275		— 129·5
60	400 " " Kraaled	466		
61	200 " " F.Y.M.	530		+ 37
62	400 " " Kraaled	520		
63	300 " " F.Y.M.	591		+ 22·5
64	400 " " Kraaled	617		
65	400 " " F.Y.M.	844		+ 298·5
66	400 " " Kraaled	474		

Variety sown :—Guinea-corn—Kaura.

Each plot $\frac{1}{4}$ acre.

Sown 27th May, 1929.

Increase (+) or Decrease (—) of 4 plots after 100 F.Y.M. C.Ns. compared with that after 400 C.Ns. Kraaled.

— 202 lb. per acre.
 — 356·5 " " "
 — 145 " " "
 — 129·5 " " "

Average — 208·3 $\pm$ 55·2 lb. per acre.

Increase (+) or Decrease (—) of 4 plots after 300 F.Y.M. C.Ns. compared with that after 400 C.Ns. Kraaled.

+ 63·5 lb. per acre.
 + 114·5 " " "
 + 157·5 " " "
 + 22·5 " " "

Average + 89·5 $\pm$ 55·2 lb. per acre.

Ridges 2' 6" apart.

Harvested 10th December, 1929.

Increase (+) or Decrease (—) of 4 plots after 200 F.Y.M. C.Ns. compared with that after 400 C.Ns. Kraaled.

— 85 lb. per acre.
 + 9·5 " " "
 — 14·5 " " "
 + 37 " " "

Average — 13·3 $\pm$ 55·2 lb. per acre.

Increase (+) or Decrease (—) of 4 plots after 400 F.Y.M. C.Ns. compared with that after 400 C.Ns. Kraaled.

+ 41·5 lb. per acre.
 + 290·5 " " "
 + 165·5 " " "
 + 298·5 " " "

Average + 199 $\pm$ 55·2 lb. per acre.

TABLE No. 8—*continued*.

Root—mean—square—difference between pairs of neighbouring control plots = 110·3.

Cost of cultivation:— { Man-days per acre = 23·8.
Cattle days „ „ = 6·0.TABLE No. 9.
BOTANIST'S COTTON STRAIN TEST.

Plot.	Strain.	Yield of seed cotton in lb. per acre.		Increase (+) or decrease (—) compared with mean of adjacent controls.
Bomo E. 1	Zaria Ginnery Commercial	52		Non-experimental.
2	Strain G		70	
3	„ Ginnery „	110		„
4	Strain D		144	34
5	„ Ginnery „	110		
6	Strain G		119	— 11
7	„ Ginnery „	150		
8	Strain D		175	+ 28·5
9	„ Ginnery „	143		
10	Strain G		97	— 56
11	„ Ginnery „	163		
12	Strain D		141	— 2·5
13	„ Ginnery „	144		
14	Strain G		118	— 15·5
15	„ Ginnery „	123		
16	Strain D		172	+ 34
17	„ Ginnery „	153		
18	Strain G		124	— 21
19	„ Ginnery „	137		
20	Strain D		231	+ 57·5
21	„ Ginnery „	210		
22	Strain G		141	— 27
23	„ Ginnery „	126		
24	Strain D		160	— 7
25	„ Ginnery „	208		
26	Strain G		122	— 48
27	„ Ginnery „	132		
28	Strain D		182	+ 28
29	„ Ginnery „	176		
30	Strain G		135	— 18
31	„ Ginnery „	130		
32	Strain D		110	Non-experimental.
33	„ Ginnery „	48		„

Variety :—Allen —Ordinary.
Strain D.
Strain G.Each plot $\frac{1}{4}$ acre.
Sown 9th July, 1929.Increase (+) or Decrease (—) of 7 plots of
Strain D compared with Ginnery Com-
mercial.Ridges 4 feet apart.
Harvested 13th January, 1930.
10th–25th February, 1930.Increase (+) or Decrease (—) of 7 plots
Strain G compared with Ginnery Com-
mercial.

TABLE No. 9—*continued*.

+ 34 lb. per acre.	- 11 lb. per acre.
+ 28.5 " " "	- 56 " " "
- 2.5 " " "	- 15.5 " " "
+ 34 " " "	- 21 " " "
+ 57.5 " " "	- 28 " " "
- 7 " " "	- 48 " " "
+ 28 " " "	- 18 " " "

Average + 24.8 ± 18.3 lb. per acre.

Average - 28.1 ± 18.3 lb. per acre.

Root—mean—square—difference between pairs of neighbouring control plots = 48.5.
 Cost of cultivation in man-days per acre = 49.7

TABLE No. 10.

COST OF CULTIVATION OF CROPS FOR SEASON. 1929-30,
 IN MAN-DAYS AND CATTLE-DAYS PER ACRE.

(a) Cattle Cultivation.

Crop.	Labour.	Prepara- tion.	Sowing and Establish- ing.	After cultiva- tion.	Harvest- ing.	Total.
Groundnuts	Hand Cattle	12.7 3.5	8.4 ...	24.2 2.2	33.7 1.4	79.0 7.1
Guinea-corn	Hand Cattle	4.4 1.6	3.0 ...	12.0 3.4	4.4 ...	24.0 5.0
Cotton	Hand Cattle	11.3 3.9	5.5 ...	14.9 10.2	11.6 ...	43.3 14.1
Gero (Interplanted)	Hand Cattle	0.3 ...	4.1 ...	13.1 2.0	4.0 ...	21.5 2.0
Mucuna (Hay) (Interplanted)	Hand Cattle	... ...	3.8 ...	9.1 2.5	2.1 ...	15.0 2.5
Mucuna cut for hay (Straight Crop)	Hand Cattle	4.0 3.9	3.9 ...	4.8 1.2	5.0 ...	17.7 5.1
Maize for Silage	Hand Cattle	... 2.2	7.5 ...	10.5 0.9	4.2 ...	22.2 3.1
Cowpeas (in Maize)	Hand Cattle	... ...	2.9 ...	11.2 2.7	5.3 ...	19.4 2.7

TABLE 10—*continued*.

(b) HAND CULTIVATION.

Crop.	Preparation.	Sowing and Estab- lishing.	After cultivation.	Harvest- ing.	Total cost.
Guinea-corn	9·7	5·7	23·1	5·1	43·6

Note.—1. Preparation includes all costs other than the non-recurrent charge of levelling and lining necessary in changing the size of ridges from 4' to 2' 6".

2. A cattle day consists of the work done by two beasts and one cattleman.

3. Mucuna cut for hay—cost of removal and stacking is not included.

TABLE No. 11.
COMPARISON OF COST OF PRODUCTION AND REVENUE FROM MAIN CROPS, 1929-30.

Crop.	Cost in Man-days per acre.	Average yield in lb. per acre.	Cost, in Man-days per lb.	Assumed Mar- ket value per lb. in pence.	* Calculated Re- turn per acre. £ s. d.	* Nett money return per Man-day in pence.	Condition of Produce.
Cotton ...	57.4	259	.222	1.50	1 9 8	6.20	Seed cotton.
Groundnuts ...	86.1	446	.193	.96	1 10 10	4.29	Decorticated.
Guinea-corn ...	29.0	403	.072	.64	0 17 2	7.10	Grain.
Gero (interplanted)	23.5	281	.084	.60	0 11 1	5.66	Grain.
Cowpeas (in maize)	22.1	126	.175	.75	0 6 7	3.57	Shelled.

Note.—1. All above crops were grown under Cattle Cultivation. In the comparison the return is calculated per man-day. Thus the costs include cattlemen but exclude any charge for cattle.

2. * Cost of transport to market calculated at 9d. per headload of 70 lb. is deducted from the gross returns.

TABLE No. 12.

STOCK ON HAND.

Crop.	Stock on Hand 1.4.29	Sales.	Deaths.	Transfers.	Births.	Purchases.	Transfers.	No. on Hand 14.3.30.
Stock Bulls ...	4	...	...	...	...	...	...	4
Cows ...	23	...	...	...	...	...	1	24
Heifers ...	13	...	...	...	...	...	...	9
" Calves ... }		...	2	...	10	...	1	13
Bulls (young) ... }	14	...	...	...	...	...	...	4
" Calves ... }		1	3	...	7	...	...	13
Working Cattle ...	18	3	1 sold unhealthy.	4	...	16	...	26

TABLE No. 13.
SHUWA CATTLE—COMPLETED LACTATIONS DURING YEAR.

Name of Cow.	No. of Cow.	Date of calving.	Period of Lactation in Days.	Total Milk Yield in lb.	No. of recorded Lactation.	Previous recorded Lactation.		REMARKS.
						1st.	2nd.	
Babeye	1	6.2.29	279	1,222 $\frac{1}{2}$	1st	...	...	Suffering from severe Kirchi.
Wajuju	4	16.8.29	88	66 $\frac{1}{4}$	2nd	621	...	
Babiye	5	26.3.29	350	1,909 $\frac{1}{4}$	1st	...	...	
Wujiye	7	30.11.28	427	3,413 $\frac{3}{4}$	1st	...	...	Gave 20 lb. in last week lactation.
Lemo	8	25.12.28	185	703 $\frac{1}{4}$	1st	...	...	
Barize	9	9.3.29	329	1,865 $\frac{3}{4}$	2nd	946 $\frac{1}{2}$	...	
Auta	10	11.2.29	173	1,119 $\frac{1}{4}$	1st	...	...	
Dafaliye	11	17.1.29	125	233 $\frac{3}{4}$	2nd	848 $\frac{3}{4}$	...	
Fodiye	12	17.11.29	77	85 $\frac{1}{4}$	2nd	64 $\frac{3}{4}$	...	
Mauduye	14	5.1.29	312	3,031 $\frac{3}{4}$	1st	...	...	
Rogozo	15	30.3.29	263	1,616 $\frac{3}{4}$	1st	...	...	
Jaliye	16	24.2.29	297	1,898	1st	...	...	
Danagiye	18	26.1.29	192	676 $\frac{1}{2}$	1st	...	...	
Nufu ...	19	16.1.29	245	1,697	2nd	2,791 $\frac{1}{2}$	...	Kirchi very severe.
Bajire	20	28.1.29	58	426 $\frac{1}{4}$	1st	...	...	
Sai ...	22	5.12.28	232	1,561 $\frac{1}{2}$	1st	...	...	
Hodiye	23	13.12.28	234	584	2nd	1,325 $\frac{1}{4}$	...	
Samaru	26	22.11.28	356	3,432 $\frac{2}{3}$	1st	...	...	
Wodiye	28	26.11.29	63	35 $\frac{3}{4}$	2nd	638	...	

BULLETIN REPORT, 1929. KANO AGRICULTURAL STATION.

Mr. J. W. R. Pedder was in charge of the station throughout the year.

Experiments and investigations into the problems arising out of mixed farming have been continued, and this season's results have produced much valuable information. A good deal of attention has been paid to the financial aspect of the system from the point of view of the native farmer. The figures obtained from our farm are not entirely applicable to a native farm but they are very useful for comparison and taken in conjunction with figures obtained from our tenant farmers they show that the economics of the system are quite sound. The following figures from our farm show that for those operations such as ridging, etc., in which it is possible to use implements, there is a saving of about sixty *per cent.* as compared with the cost of hand labour.

						Cattle.		Hand Labour.						
						s.	d.							
Ridging	...	...	...	...	...	1	2	per acre.		5	6	per acre.		
Cultivation	...	...	...	...	...	1	2½	"	"	}	6	0½	"	"
Weeding and Singling	...	...	...	...	...	1	11½	"	"					
Total	...	...	...	...	...	4	4	"	"		11	6½	"	"

In working out the cost of cattle cultivation all possible charges have been included many of which would not be applicable to a native farmer and are peculiar to our experimental stations alone. Of course, the light sandy soil of the Kano district is particularly suited to the use of implements and the costs are therefore lower than they would be say at Zaria where the soil is much heavier.

During the season under review six farmers in one district gave the system a trial, and from the agricultural point of view were very successful. Other farmers in the neighbourhood propose to adopt it this season. It appears that a farmer can cultivate up to four times as great an area under this system as by hand cultivation. The use of ploughs for making ridges gave rise to a minor problem, in that we found that we could only make the ridges two feet six inches apart instead of the usual three feet six inches. The question therefore arose whether the smaller ridges, and consequent smaller depth of soil would adversely affect the yield of the crops to any appreciable extent. All the main crops have now been tested on the small ridges and although the results obtained are not conclusive they indicate that with suitable spacing no loss of yield need occur. Manuring experiments have again received a

good deal of attention, and the results again confirm the superiority of pen-made farm-yard manure, both in immediate and residual effect, over other forms of dung and artificial manures on this particular type of soil.

Increased experience in the use of cattle as draft animals has led to improvements in the structure of ploughs and cultivators and very serviceable implements are now made entirely by native artisans out of materials obtained locally.

Actual cultivations have also undergone some changes. It has been found more satisfactory to grow bulrush millet interplanted in the groundnut crop instead of in the guinea-corn crop as was formerly the practice. The bulrush millet grows so rapidly that intercultivation is soon rendered impossible and the interplanted guinea-corn suffers in consequence.

Cross cultivation has been practised with success and has materially lessened the amount of hand cultivation on the top of the ridge which was previously found necessary.

RAINFALL AND TEMPERATURE.

See Table No. 1.

The monthly rainfall and temperature is given for the season under review together with the average rainfall for the last six years.

ARTIFICIAL MANURE EXPERIMENT—GUINEA-CORN.

RESIDUAL EFFECT.

See Table No. 2.

	Weight of grain on the head in lbs. per acre.	Odds that difference is significant.
Average yield of 18 control plots previously receiving F.Y.M. 3 tons per acre	1,239	—
Average difference of 4 plots previously receiving ground Nigerian rock phosphate at the rate of 200 lbs. per acre	— 253 ± 85	534 : 1
Average difference of 3 plots unmanured	— 276 ± 98	390 : 1
Average difference of 3 plots previously receiving ground Nigerian rock phosphate 200 lbs. per acre plus ammonium sulphate 75 lbs. per acre	— 151 ± 98	14 : 1
Average difference of 3 plots previously receiving ground Nigerian rock Phosphate 200 lbs. per acre plus potash 60 lbs. per acre	— 165 ± 98	21 : 1
Average difference of 3 plots previously receiving ground Nigerian rock phosphate 200 lbs. per acre plus F.Y.M. 3 tons per acre	— 41 ± 98	2 : 1

This experiment was started three years ago, with the primary idea of discovering under what condition (if any) Nigerian rock phosphate can profitably be used, *i.e.*, whether we should have to advise people to use it in conjunction with farm-yard manure, to use it for some particular crop or to use it in conjunction with a potash manure. The manures were applied to groundnuts in the first year, to cotton in the second year while in the third year no manures were applied, a test crop of guinea-corn being grown to test the residual value of the manures. The results over the three years have been remarkably consistent. There is no evidence that any particular crop responds particularly well to a dressing of phosphate and the addition of phosphate to farm-yard manure caused no increase in yield over that obtained from farm-yard manure alone, in fact neither of the combinations of manures tested was as effective as the very moderate dressing of three tons of farm-yard manure. It would seem that the phosphate possibly had some slight effect since the treated plots in every case yielded slightly better than unmanured plots, but the increases were so small that it is obvious that it is not an economic proposition. In a similar experiment carried out on the heavier soil at Samaru there was some evidence to show that the phosphate had a very definite residual effect and became slowly available in the following year, but on the light Kano soil there seems to be no residual effect whatever. As result of this and several other experiments of a similar nature which we have carried out during the last few years it is evident that the only form of manure which can be regarded as an economic proposition is farmyard manure, but it is quite possible that other forms of organic manures would be equally effective if they could be supplied sufficiently cheaply.

FARM-YARD MANURE *versus* KRAALING EXPERIMENT.

GUINEA-CORN, RESIDUAL EFFECT.

See Table No. 3.

	Weight of grain on the head in lb. per acre.	Odds that difference is significant.
Average yield of 17 control plots previously 400 cattle nights per acre kraaled	1,618	—
Average difference of 4 plots previously 400 cattle nights farm-yard manure per acre	+ 169 ± 109	17 : 1
Average difference of 4 plots previously 300 cattle nights farm-yard manure per acre	+ 25 ± 109	—
Average difference of 4 plots previously 200 cattle nights farm-yard manure per acre	— 18 ± 109	—
Average difference of 4 plots previously 100 cattle nights farm-yard manure per acre	— 121 ± 109	7 : 1

The results obtained from this experiment last year confirmed those obtained from a similar experiment carried out at Samaru and showed that the manure produced in a pen in 200 cattle nights is equal in value to the manure produced in 400 cattle nights by cattle kraaled on the fields at night in the normal native method. No manures were applied this year as we wished to ascertain the residual value of farm-yard manure compared with that of manure applied by kraaling. The results given above show very clearly that the residual effect of farm-yard manure in the second year is very much greater than that of kraaling. This is important from the point of view of the native farmer for very few of the latter can afford to have the same land kraaled in two consecutive seasons, and in fact, land is often cropped for two, three or four years before it has another dressing of manure, except of course in the immediate vicinity of Kano or other big towns where town manure is available. It greatly emphasises the value of making farm-yard manure in pens and shows how wasteful the kraaling method really is especially in an area such as the Kano Province where owing to the sandy nature of the soil manure is a very valuable commodity.

TREATMENT OF MANURE EXPERIMENT—COTTON.

RESIDUAL EFFECT.

See Table No. 4.

	Weight of seed cotton in lbs. per acre.	Odds that difference is significant.
Average yield of 9 control plots manured previously with native made manure at the rate of 300 cattle nights per acre	• 322	--
Average difference of 4 plots kraaled previously at the rate of 300 cattle nights per acre	+ 4.5 ± 17	—
Average difference of 4 plots manured previously with F.Y.M. at the rate of 300 cattle nights per acre	+ 41.5 ± 17	121 : 1

Farm-yard manure shows superiority in residual effect over manure from both animals kraaled *in situ*, and native-made manure. This result confirms what was generally the opinion that the application of farm-yard manure is superior in effect to other methods of applying dung. This is no doubt partly due to the extra humus which the soil obtains from farm-yard manure.

VARIOUS RATES OF APPLYING FARM-YARD MANURE—GUINEA-CORN.

See Table No. 5.

	Weight of grain on the head in lbs. per acre.	Odds that difference is significant.
Average yield of 14 control plots receiving no manure	654	—
Average difference of 4 plots receiving one ton per acre farm-yard manure	+ 23 ± 144	—
Average difference of 4 plots receiving two tons per acre farm-yard manure...	+ 96 ± 144	3 : 1
Average difference of 4 plots receiving three tons per acre farm-yard manure	+ 239 ± 144	19 : 1
Average difference of 4 plots receiving four tons per acre farm-yard manure...	+ 259 ± 144	49 : 1

The results of this experiment, after the first year, are approximately what was to be expected. The yield from the unmanured plots is fair. It would appear that farm-yard manure applied at the rate of three tons per acre is the most economic dressing.

This experiment is to be continued over a period of four years when more definite information on the subject should be obtained.

A further experiment is being incorporated to test whether it is best to apply one ton of farm-yard manure per acre every year, two tons every second year, three tons every third year or four tons every fourth year.

INTERPLANTED GERO SPACING EXPERIMENT IN GROUNDNUTS.

See Table No. 6.

	Weight of grain on the head in lbs. per acre.	Odds that difference is significant.
Average yield of gero for 14 control plots <i>i.e.</i> , 5 rows gero 6 feet apart interplanted in groundnuts	1,196	—
Average difference of 4 plots gero 3 rows 10 feet apart interplanted in groundnuts	+ 73 ± 131	2 : 1
Average difference of 4 plots gero 7 rows 4 feet 3 inches apart interplanted in groundnuts	+ 46 ± 131	—

Groundnuts.

Average yield of groundnuts for 14 control plots <i>i.e.</i> , 5 rows gero interplanted,	763	—
Average difference of 4 plots groundnuts alone	+ 809.5 ± 72	∞ : 1
Average difference of 4 plots groundnuts with 3 rows gero, interplanted ...	+ 325.5 ± 72	100,000 : 1
Average difference of 4 plots groundnuts with 7 rows gero interplanted ...	- 147 ± 72	45 : 1

This is an extremely instructive experiment. There is no significant difference in the yield of gero (bulrush millet) when planted in three, five or seven rows per plot. This has confirmed results of an experiment conducted last season with the same crop but interplanted in mucuna, and is presumably due to the fact that gero tillers very freely.

In the case of groundnuts the result is what might have been expected, an increase in the number of stands of gero reducing the yield of groundnuts. Therefore by careful adjustment of the number of stands of gero it is possible to get a full crop of gero and very nearly a full crop of groundnuts. The figures given below illustrate the importance of this from the financial point of view and it is interesting to note that the system of intercropping gero and groundnuts is commonly practised in the groundnut growing area of Kano.

Average yield per acre.			Value.		Gross return per acre.	
	Groundnuts undecorticated.	Gero on the head.	Groundnuts 62% decorticated @ 0.97d. per lb.	Gero 0.54d. per lb. on the head.		
			s. d.	s. d.	£	s. d.
Groundnuts and 5 rows gero	763	1,196	32 2	53 9	4	11 11
Groundnuts alone ...	1,572	—	78 0	—	3	18 0
Groundnuts and 3 rows gero	1,088	1,123	54 6	50 6	5	5 0
Groundnuts and 7 rows gero	616	1,242	30 10	55 10	4	6 8

From these figures it would appear that very material benefit is derived from interplanting three rows of gero in a groundnut crop.

It remains to be proved whether two, three, or four rows of interplanted gero are most economic and it is hoped this information will be obtained from an experiment commencing next season.

WIDTH OF RIDGES EXPERIMENT—GUINEA-CORN.

See Table No. 7.

	Weight on the head in lbs. per acre.	Odds that difference is significant.
Average yield of 9 control plots ridges 3 feet 6 inches apart spaced 3 feet 0 inch	1,423	
Average difference 8 plots ridges 2 feet 6 inches apart spaced 3 feet 0 inch ...	+ 18 ± 86.6	—

There is no outstanding difference in yields obtained from guinea-corn planted on two feet six inch or three feet six inch ridges. This experiment was designed to observe the effect on the yield of planting guinea-corn on two feet six inch ridges. From this result it would therefore appear that the two feet six inch ridges, which are more convenient for cultivation by animal-drawn implements, are not detrimental to the ultimate yield of the crop.

WIDTH OF RIDGES OF EXPERIMENT—COTTON.

See Table No. 8.

	Weight of seed cotton in lbs. per acre.	Odds that difference is significant.
Average yield of 9 control plots, ridges 3 feet 6 inches apart spaced 1 foot 6 inches	383	
Average difference of 4 plots ridges 2 feet 6 inches apart spaced 2 feet 2 inches	+ 31 $\pm$ 27.3	7 : 1
Average difference of 4 plots ridges 2 feet 6 inches apart spaced 1 foot 6 inches...	+ 3 $\pm$ 27.3	—

This experiment is the complement of the previous one, and it again shows that if the plants are suitably spaced on the ridges the actual distance between the ridges is immaterial. As two feet six inches between ridges is the most suitable distance for the use of ploughs, and the normal distance between ridges in this area is about three feet six inches this information was necessary before we could advocate the use of ploughs to native farmers.

COST OF MAIN CROPS IN MAN-DAYS PER ACRE.

See Table No. 9.

Possibly due to even more effective use of cattle-drawn implements, the cost of preparation of land for groundnut, cotton and guinea-corn crops has been considerably reduced.

In case of practically all crops, the cost of cultivation in man-days per acre, has also been reduced due to the same cause. The cost of harvesting is normal for the yields obtained.

COST OF PRODUCTION AND REVENUE FROM MAIN CROPS.

See Table No. 10.

Situated near a large town grain crops are easily the most remunerative to grow. Due to the falling price of groundnuts, the better yields of seed cotton and the steady price obtained in local markets, these two crops give approximately the same monetary return per man-day. The yields of crops on native farms will approximately be thirty-three *per cent.* less than those obtained on the Plantation.

TABLE No. 1.

MONTHLY RAINFALL AND MEAN TEMPERATURE.

Month.				Rainfall in inches, Plantation.	Rainfall in inches, Survey School.	Average fall over 6 years, Plantation.	Mean Temperature in the shade Survey School.
January	...	...	...	...	...	...	70.4
February	...	...	...	...	...	...	77.6
March	...	...	...	...	...	0.17	83.9
April	...	...	...	...	...	0.31	89.2
May	...	...	...	2.15	2.44	2.51	88.8
June	...	...	...	6.02	5.17	5.16	81.4
July	...	...	...	9.09	7.65	8.62	79.5
August	..	...	...	12.20	13.03	11.84	76.5
September	...	...	...	4.19	4.04	5.19	81.6
October	...	...	...	0.45	0.50	0.64	80.9
November	...	...	...	...	...	...	78.2
December	...	...	...	...	..	...	68.8
Total	...	...	...	34.10	32.83	34.44	78.9

TABLE No. 2.
ARTIFICIAL MANURE EXPERIMENT—GUINEA-CORN.
RESIDUAL EFFECT.

No. of Plot.	Treatment.	Weight on the head in lbs. per acre.	Increase (+) or decrease (—) compared with mean of adjacent controls.
I. 43–59.			
43	1	Farm-yard manure 3 tons per acre	1,536
	2	P ₂ O ₅ 200 lb. per acre	904
44	1	Farm-yard manure 3 tons per acre	1,184
	2	Unmanured	1,268
45	1	Farm-yard manure 3 tons per acre	1,556
	2	P ₂ O ₅ 200 lb. per acre—(NH ₄) ₂ SO ₄ 75 lb. per acre	1,412
46	1	Farm-yard manure 3 tons per acre	1,500
	2	P ₂ O ₅ 200 lb.—K ₂ O 60 lb. per acre	1,340
47	1	Farm-yard manure 3 tons per acre	1,444
	2	F. Y. M. 3 tons per acre—P ₂ O ₅ 200 lb. per acre	1,232
48	1	Farm-yard manure 3 tons per acre	1,372
	2	P ₂ O ₅ 200 lb. per acre	1,152
49	1	Farm-yard manure 3 tons per acre	1,388
	2	Unmanured	960
50	1	Farm-yard manure 3 tons per acre	1,384
	2	P ₂ O ₅ 200 lb. per acre—(NH ₄) ₂ SO ₄ 75 lb. per acre	1,112
51	1	Farm-yard manure 3 tons per acre	1,232
	2	P ₂ O ₅ 200 lb.—K ₂ O 60 lb. per acre	1,066
52	1	Farm-yard manure 3 tons per acre	1,320
	2	F. Y. M. 3 tons per acre—P ₂ O ₅ 200 lb. per acre	1,282
53	1	Farm-yard manure 3 tons per acre	1,194
	2	P ₂ O ₅ 200 lb. per acre	990
54	1	Farm-yard manure 3 tons per acre	1,210
	2	Unmanured	910
55	1	Farm-yard manure 3 tons per acre	1,222
	2	P ₂ O ₅ 200 lb.—(NH ₄) ₂ SO ₄ 75 lb. per acre	1,058
56	1	Farm-yard manure 3 tons per acre	1,196
	2	P ₂ O ₅ 200 lb.—K ₂ O 60 lb. per acre	860
57	1	Farm-yard manure 3 tons per acre	832
	2	F. Y. M. 3 tons per acre—P ₂ O ₅ 200 lb. per acre	856
58	1	Farm-yard manure 3 tons per acre	828
	2	P ₂ O ₅ 200 lb. per acre	758
59	1	Farm-yard manure 3 tons per acre	920
	2	Farm-yard manure 3 tons per acre	988
			Non-experimental.

TABLE No. 2.—*continued.*

Each plot $\frac{1}{2}$ acre. Sown 26th May, 1929. Harvested 8th November, 1929.

" " 2' 6" ridges. Animal cultivation.

Percentage grain to grain on the head = 72%.

Increase (+) or decrease (-) of 4 plots with P_2O_5 200 lbs. per acre compared with Farm-yard manure 3 tons per acre.	Increase (+) or decrease (-) of 3 plots unmanured com- pared with Farm-yard ma- nure 3 tons per acre.	Increase (+) or decrease (-) of 3 plots with P_2O_5 200 lbs. per acre and $(NH_4)_2SO_4$ 75 lbs. per acre compared with F. Y. M. 3 tons per acre.
---	--	---

- 456 lbs. per acre.

- 228 " " "

- 212 " " "

- 116 " " "

- 102 lbs. per acre.

- 426 " " "

- 306 " " "

- 116 lbs. per acre.

- 196 " " "

- 151 " " "

Average - 253 ± 85 lbs. per acre.

Average - 276 ± 98 lbs. per acre.

Average - 154 ± 98 lbs. per acre.

Increase (+) or decrease (-) of 3 plots
with P_2O_5 200 lbs. per acre and K_2O 60
lbs. per acre compared with Farm-yard
manure 3 tons per acre.

- 132 lbs. per acre.

- 210 " " "

- 154 " " "

Average - 165 ± 98 lbs. per acre.

Increase (+) or decrease (-) of 3 plots
with Farm-yard manure 3 tons per acre
and P_2O_5 200 lbs. per acre compared with
Farm-yard manure 3 tons per acre.

- 176 lbs. per acre.

+ 25 " " "

+ 26 " " "

Average - 41 ± 98 lbs. per acre.

Root—mean—square—difference between pairs of neighbouring controls = 170.

Cost of cultivation in man-days per acre = 20.7.

TABLE No. 3.

FARM-YARD MANURE *versus* KRAALING EXPERIMENT, GUINEA-CORN
RESIDUAL EFFECT.

N. of Plot.	Treatment.	Weight on the head in lbs. per acre.	Increase (+) or decrease (-) compared with mean of adja- cent controls.
I. 1-33			
1	At rate of 400 cattle nights per acre kraaled	1,924	
2	" " " 400 " " " " F. Y. M.	1,902	+ 92
3	" " " 400 " " " " kraaled	1,696	
4	" " " 300 " " " " F. Y. M.	1,800	+ 78
5	" " " 400 " " " " kraaled	1,748	
6	" " " 200 " " " " F. Y. M.	1,728	+ 44
7	" " " 400 " " " " kraaled	1,620	
8	" " " 100 " " " " F. Y. M.	1,402	- 238
9	" " " 400 " " " " kraaled	1,660	
10	" " " 400 " " " " F. Y. M.	1,868	+ 205
11	" " " 400 " " " " kraaled	1,666	
12	" " " 300 " " " " F. Y. M.	1,602	+ 25
13	" " " 400 " " " " kraaled	1,488	
14	" " " 200 " " " " F. Y. M.	1,114	- 277
15	" " " 400 " " " " kraaled	1,294	
16	" " " 100 " " " " F. Y. M.	1,042	- 293
17	" " " 400 " " " " kraaled	1,376	
18	" " " 400 " " " " F. Y. M.	1,628	+ 194
19	" " " 400 " " " " kraaled	1,492	
20	" " " 300 " " " " F. Y. M.	1,350	- 40
21	" " " 400 " " " " kraaled	1,288	
22	" " " 200 " " " " F. Y. M.	1,616	+ 42
23	" " " 400 " " " " kraaled	1,860	
24	" " " 100 " " " " F. Y. M.	1,904	11
25	" " " 400 " " " " kraaled	1,971	
26	" " " 400 " " " " F. Y. M.	2,082	+ 185
27	" " " 400 " " " " kraaled	1,824	
28	" " " 300 " " " " F. Y. M.	1,802	+ 37
29	" " " 400 " " " " kraaled	1,706	
30	" " " 200 " " " " F. Y. M.	1,662	+ 118
31	" " " 400 " " " " kraaled	1,382	
32	" " " 100 " " " " F. Y. M.	1,512	+ 63
33	" " " 400 " " " " kraaled	1,516	

Each plot $\frac{1}{2}$ acre. Sown 25th May, 1929. Harvested 7th-8th November, 1929.

" 2' 6" ridges. Animal cultivation.

Percentage grain to grain on the head = 72%

Increase (+) or decrease (-) of 4 plots
with 400 cattle nights Farm-yard manure
per acre compared with those kraaled
with 400 cattle nights per acre.

Increase (+) or decrease (-) of 4 plots
with 300 cattle nights Farm-yard manure
per acre compared with those kraaled
with 400 cattle nights per acre.

TABLE No. 3—*continued*.

+ 92 lbs. per acre.
 + 205 " " "
 + 194 " " "
 + 185 " " "

Average + 169 ± 109 lbs. per acre.

Increase (+) or decrease (-) of 4 plots
 with 200 cattle nights Farm-yard manure
 per acre compared with those kraaled
 with 400 cattle nights per acre.

+ 44 lbs. per acre.
 - 277 " " "
 + 42 " " "
 + 118 " " "

Average - 18 ± 109 lbs. per acre.

+ 78 lbs. per acre.
 + 25 " " "
 - 40 " " "
 + 37 " " "

Average + 25 ± 109 lbs. per acre.

Increase (+) or decrease (-) of 4 plots
 with 100 cattle nights Farm-yard manure
 per acre compared with those kraaled
 with 400 cattle nights per acre.

- 238 lbs. per acre.
 - 293 " " "
 - 11 " " "
 + 63 " " "

Average - 120 ± 109 lbs. per acre.

Root—mean—square—difference between pairs of neighbouring controls = 209.5.
 Cost of cultivation in man-days per acre = 19.5.

TABLE No. 4.

TREATMENT OF MANURE EXPERIMENT. RESIDUAL EFFECT.
 COTTON K. 1.

No. of Plot.	Treatment.	Weight of seed cotton in lbs. per acre.	Increase (+) or decrease (-) compared with mean of adjacent controls.
B 1-17			
1	Native Made Manure 300 cattle nights per acre ...	227	
2	Kraaled 300 cattle nights per acre ...	294	+ 40
3	Native Made Manure 300 cattle nights per acre ...	282	
4	Farm-yard manure	370	+ 68
5	Native Made Manure " " " " " ...	323	
6	Kraaled " " " " " ...	362	+ 42
7	Native Made Manure " " " " " ...	317	
8	Farm-yard manure " " " " " ...	348	+ 24
9	Native Made Manure " " " " " ...	332	
10	Kraaled " " " " " ...	292	- 42
11	Native Made Manure " " " " " ...	336	
12	Farm-yard manure " " " " " ...	337	+ 20
13	Native Made Manure " " " " " ...	281	
14	Kraaled " " " " " ...	241	- 22
15	Native Made Manure " " " " " ...	246	
16	Farm-yard manure " " " " " ...	295	+ 45
17	Native Made Manure " " " " " ...	254	

Each plot $\frac{1}{4}$ acre. Sown 13th June, 1929. Harvested { November, 13th-23rd } 1929.
 { December, 5th 24th }
 { January, 22nd-29th, 1930.

" " 2' 6" ridges. Animal cultivation.

Increase (+) or decrease (-)
 of 4 plots kraaled compared
 with Native Made Manure.

+ 40 lbs. per acre.
 + 42 " " "
 - 42 " " "
 - 22 " " "

Average + 4.5 ± 17 lbs. per acre.

Increase (+) or decrease (-) of
 4 plots Farm-yard manure compared
 with Native Made Manure.

+ 68 lbs. per acre.
 + 24 " " "
 + 29 " " "
 + 45 " " "

Average + 41.5 ± 17 lbs. per acre.

Root—mean—square—difference between pairs of neighbouring controls = 34.
 Cost of cultivation in man-days per acre = 42.0.

TABLE No. 5.

VARIOUS RATES OF APPLYING FARM-YARD MANURE
EXPERIMENT, GUINEA-CORN.

No. of Plot.	Treatment.	Weight on the head in lbs. per acre.	Increase (+) or decrease (-) compared with mean of adjacent controls.
M. 27-59.			
27	No manure applied	400	
28	F. Y. M. 1 ton per acre	576	+ 90
29	No manure applied	572	
30	F. Y. M. 2 tons per acre	488	- 130
31	No manure applied	664	
32	F. Y. M. 3 tons per acre	698	+ 149
33	No manure applied	434	
34	F. Y. M. 4 tons per acre	770	+ 293
35	No manure applied	520	
36	F. Y. M. 1 ton per acre	546	+ 67
37	No manure applied	438	
38	F. Y. M. 2 tons per acre	588	+ 40
39	No manure applied	658	
40	F. Y. M. 3 tons per acre	1,376	+ 483
41	No manure applied	1,128	
42	F. Y. M. 4 tons per acre	1,704	+ 415
43	No manure applied	1,450	
44	F. Y. M. 1 ton per acre	1,226	- 130
45	No manure applied	1,262	
46	F. Y. M. 2 tons per acre	1,318	+ 274
47	No manure applied	826	
48	F. Y. M. 3 tons per acre	988	+ 267
49	No manure applied	616	
50	F. Y. M. 4 tons per acre	896	+ 261
51	No manure applied	654	
52	F. Y. M. 1 ton per acre	576	+ 64
53	No manure applied	370	
54	F. Y. M. 2 tons per acre	592	+ 200
55	No manure applied	414	
56	F. Y. M. 3 tons per acre	480	+ 57
57	No manure applied	432	
58	F. Y. M. 4 tons per acre	656	213
59	No manure applied	454	

Each plot $\frac{1}{4}$ acre. Sown 24th and 25th May, 1929. Harvested 6th November, 1929.

" " 2' 6" ridges. Animal cultivation.

Percentage grain to grain on the head = 72%.

Increase (+) or decrease (-) of
4 plots manured with 1 ton
F.Y.M. per acre compared with
plots unmanured.

Increase (+) or decrease (-)
of 4 plots manured with 2 tons
F.Y.M. per acre compared with
plots unmanured.

TABLE No. 5—*continued*.

+ 90 lbs. per acre.	- 130 lbs. per acre.
+ 67 „ „ „	+ 40 „ „ „
-130 „ „ „	+ 274 „ „ „
+ 64 „ „ „	- 200 „ „ „
Average +23±144 lbs. per acre.	Average +96±144 lbs. per acre.
Increase (+) or decrease (—) of 4 plots manured with 3 tons F.Y.M. per acre compared with plots unmanured.	Increase (+) or decrease (—) of 4 plots manured with 4 tons F.Y.M. per acre compared with plots unmanured.
+ 149 lbs. per acre.	+ 293 lbs. per acre.
+ 483 „ „ „	- 415 „ „ „
+ 267 „ „ „	+ 261 „ „ „
+ 64 „ „ „	+ 213 „ „ „
Average +239±144 lbs. per acre.	Average + 295±144 lbs. per acre.

Root—mean—square—difference between pairs of neighbouring controls = 228.

Cost of cultivation in man-days per acre = 30·9.

TABLE No. 6.

INTERPLANTED GERO SPACING EXPERIMENT IN GROUNDNUTS.
YIELDS OF GERO.

No. of plot.	Interplanting.	Weight on the head in lbs. per acre.	Increase (+) or decrease (-) compared with mean of adjacent controls.
M. 1-26.			
1	Gero with 5 rows per plot	1,584	
2	Groundnuts sole crop		
3	Gero with 5 rows per plot	1,612	
4	" " 3 " " " "	1,427	- 65
5	" " 5 " " " "	1,372	
6	" " 7 " " " "	1,677	+ 133
7	" " 5 " " " "	1,716	
8	Groundnuts sole crop		
9	Gero with 5 rows per plot	1,920	
10	" " 3 " " " "	1,597	- 218
11	" " 5 " " " "	1,710	
12	" " 7 " " " "	1,554	- 121
13	" " 5 " " " "	1,641	
14	Groundnuts sole crop		
15	Gero with 5 rows per plot	960	
16	" " 3 " " " "	930	+ 14
17	" " 5 " " " "	872	
18	" " 7 " " " "	938	- 6
19	" " 5 " " " "	1,016	
20	Groundnuts sole crop		
21	Gero with 5 rows per plot	1,006	
22	" " 3 " " " "	710	- 25
23	" " 5 " " " "	464	
24	" " 7 " " " "	616	+ 178
25	" " 5 " " " "	412	
26	" " 5 " " " "	462	Non Experimental

Each plot $\frac{1}{4}$ acre. Sown 28th May, 1929. Harvested 27th and 28th August, 1929.

" " 2' 6" ridges. Animal cultivation.

Percentage grain to grain on the head = 58%.

Increase (+) or decrease (-) of
4 plots with 3 rows of Gero per
plot compared with those plots
of gero 5 rows per plot.

- 65 lbs. per acre.
- 218 " " "
+ 14 " " "
- 25 " " "

Average - 73 = 131 lbs. per acre.

Increase (+) or decrease (-) of
4 plots with 7 rows of Gero per
plot compared with those plots
of gero 5 rows per plot.

+ 133 lbs. per acre.
- 121 " " "
- 6 " " "
+ 178 " " "

Average + 46 = 131 lbs. per acre.

Root-mean-square-difference between pairs of neighbouring controls = 263.

TABLE No. 6—*continued*.
YIELDS OF GROUNDNUTS.

No. of Plot.	Interplanted.	Weight in lbs. per acre undecorticated.	Increase (+) or decrease (–) compared with mean of adjacent controls.
M. 1–26.			
1	Groundnuts and Gero 5 rows per plot	1,244	
2	Groundnuts	1,920	+ 859
3	Groundnuts and Gero 5 rows per plot	878	
4	" " " 3 " " "	1,314	+ 401
5	" " " 5 " " "	948	
6	" " " 7 " " "	764	– 123
7	" " " 5 " " "	826	
8	Groundnuts	1,978	+1,132
9	Groundnuts and Gero 5 rows per plot	866	
10	" " " 3 " " "	974	+ 200
11	" " " 5 " " "	682	
12	" " " 7 " " "	386	– 237
13	" " " 5 " " "	565	
14	Groundnuts	1,260	+ 705
15	Groundnuts and Gero 5 rows per plot	545	
16	" " " 3 " " "	1,164	+ 572
17	" " " 5 " " "	639	
18	" " " 7 " " "	562	– 89
19	" " " 5 " " "	664	
20	Groundnuts	1,276	+ 542
21	Groundnuts and Gero 5 rows per plot	804	
22	" " " 3 " " "	842	+ 125
23	" " " 5 " " "	630	
24	" " " 7 " " "	534	– 139
25	" " " 5 " " "	716	
26	" " " 5 " " "	676 Non-experimental	

Each plot $\frac{1}{4}$ acre. Sown 10th to 11th June, 1929. Harvested 21st to 31st October, 1929.

" " 2' 6" ridges. Animal cultivation.

Percentage Groundnuts decorticated to undecorticated 63%.

Increase (+) or decrease (–) of
4 plots of Groundnuts with 3
rows Gero interplanted.

+ 401 lbs. per acre.
+ 200 " " "
+ 572 " " "
+ 125 " " "

Increase (+) or decrease (–) of
4 plots of Groundnuts with no
Gero interplanted.

+ 859 lbs. per acre.
+ 1,132 " " "
+ 705 " " "
+ 542 " " "

Average + 324.5 ± 72 lbs. per acre.

Average + 809.5 ± 72 lbs. per acre.

Increase (+) or decrease (–) of
4 plots of Groundnuts with 7
rows of Gero interplanted.

– 123 lbs. per acre.
– 237 " " "
– 89 " " "
– 139 " " "

Average – 147 ± 72 lbs. per acre.

Root—mean—square—difference between pairs of neighbouring controls = 144.

Cost of cultivation in man-days per acre = 89.8.

TABLE No. 7.

WIDTH OF RIDGES EXPERIMENT, GUINEA-CORN.

No. of Plot.	Width of Ridges.	Weight on the head in lb per acre.	Increase (+) or decrease (-) compared with mean of adjacent controls.
H. 43-59			
43	3' 6" ridge	1,832	
44	2' 6" "	1,288	- 313
45	3' 6" "	1,370	
46	2' 6" "	1,384	+ 85
47	3' 6" "	1,228	
48	2' 6" "	1,296	+ 80
49	3' 6" "	1,204	
50	2' 6" "	1,296	+ 123
51	3' 6" "	1,142	
52	2' 6" "	1,276	+ 79
53	3' 6" "	1,252	
54	2' 6" "	1,460	- 2
55	3' 6" "	1,672	
56	2' 6" "	1,566	- 15
57	3' 6" "	1,490	
58	2' 6" "	1,662	+ 109
59	3' 6" "	1,616	

Each plot $\frac{1}{4}$ acre. Sown 26th May, 1929. Harvested 7th to 13th November, 1929.

Hand cultivation.

All plants 3 feet apart on the ridge.

Percentage grain to grain on the head = 72%

Increase (+) or decrease (-) of
8 plots with ridges 2' 6" apart
compared with ridges 3' 6"
apart.

- 313 lbs. per acre.

+ 85 " " "

+ 80 " " "

+ 123 " " "

+ 79 " " "

- 2 " " "

- 15 " " "

+ 109 " " "

Average + 18 $\pm$ 86.6 lbs. per acre.

Root—mean—square—difference between pairs of neighbouring controls = 224.3.

Cost of cultivation in man-days per acre = 40.2.

TABLE No. 8.

WIDTH OF RIDGES EXPERIMENT, COTTON.

No. of Plot.	Width of Ridges.	Weight of seed cotton in lbs. per acre.	Increase (+) or decrease (-) compared with mean of adjacent controls.
B. 18-34			
18	Ridges 3' 6" apart. Spacing 1' 6"	353	
19	" 2' 6" " " 2' 2"	324	+ 3
20	" 3' 6" " " 1' 6"	290	
21	" 2' 6" " " 1' 6"	289	- 5
22	" 3' 6" " " 1' 6"	298	
23	" 2' 6" " " 2' 2"	339	- 2
24	" 3' 6" " " 1' 6"	385	
25	" 2' 6" " " 1' 6"	403	+ 2
26	" 3' 6" " " 1' 6"	417	
27	" 2' 6" " " 2' 2"	479	+ 89
28	" 3' 6" " " 1' 6"	363	
29	" 2' 6" " " 1' 6"	359	- 39
30	" 3' 6" " " 1' 6"	433	
31	" 2' 6" " " 2' 2"	467	+ 33
32	" 3' 6" " " 1' 6"	435	
33	" 2' 6" " " 1' 6"	507	+ 53
34	" 3' 6" " " 1' 6"	473	

Each plot $\frac{1}{4}$ acre. Sown 11th and 12th June, 1929. Harvested November 6th to 26th, 1929; December 24th to 28th, 1929.

Hand cultivation.

Increase (+) or decrease (-) of 4 plots with ridges 2' 6" apart and plants spaced 2' 2" compared with those 3' 6" apart and spaced 1' 6".

+ 3 lbs. per acre.
 - 2 " " "
 + 89 " " "
 + 33 " " "

Average + 31 ± 27.3 lbs. per acre.

Increase (+) or decrease (-) of 4 plots with ridges 2' 6" apart and plants spaced 1' 6" compared with those 3' 6" apart and spaced 1' 6".

- 5 lbs. per acre.
 + 2 " " "
 - 39 " " "
 + 53 " " "

Average + 3 ± 27.3 lbs. per acre.

Root—mean—square—difference between pairs of neighbouring controls = 54.6.

Cost of cultivation in man-days per acre = 62.4.

TABLE No. 9.

COST OF MAIN CROPS IN MAN-DAYS PER ACRE.

Crop.				Prepara- tion.	Plant- ing.	Cultiva- tion.	Harvest- ing.	Store Work.	Total M.D.P.A.
Guinea-corn	...	...	...	3·5	2·9	7·5	11·0	0·9	25·8
Groundnuts	...	...	...	9·1	5·9	12·6	39·5	0·5	67·6
Cotton	...	...	...	6·9	5·8	14·1	21·9	0·4	49·1
Gero	...	...	...	3·5	1·6	7·0	9·6	1·1	22·8
Legumes Single Crop	...	...	...	11·1	2·7	13·3	10·0	2·6	39·7
Legumes Interplanted	...	...	...	0·5	0·4	1·4	1·9	—	4·2

TABLE No. 10.

COMPARISON OF COST OF PRODUCTION AND REVENUE
FROM MAIN CROPS. 1929-30 SEASON.

Crop.	Cost in man-days.	Average yield lbs. per acre.	Cost of Crop in man-days per lb.	Assumed market value per lb.	*Calculated return per acre at nearest market.	*Monetary return per man-day.	Nature of crop as sold.
Guinea-corn ...	25·8	1,228	0·021	0·54d.	£ s. d. 2 13 7	25·7d.	Grain on head
Cotton ...	49·1	361	0·136	2·0d.	2 19 4	14·5d.	Seed cotton
Groundnuts ...	67·6	976	0·069	0·97d.	3 18 10	14·0d.	Decortica- ted
Gero ...	22·8	1,196	0·019	0·54d.	2 12 2	28·2d.	Grain on head

* After allowing for the cost of transport to the market at

·04d. per lb. for Guinea-corn

·08d. " " " Cotton

·05d. " " " Groundnuts

·04d. " " " Gero

KWORRE IRRIGATION FARM, SOKOTO : BULLETIN REPORT, 1929.

The following Superintendents of Agriculture worked on the station :—

Mr. J. G. Reynard from 1st to 18th January.

„ B. G. Owen from 7th January to 31st December.

„ J. H. Palmer from 6th April to 22nd August and 18th October to 31st December.

The results detailed below and in the accompanying tables refer to the dry season 1928–29 and the rainy season of 1929. During the former the more promising results were with wheat and guinea-corn, but in the rains only rice produced data of general interest. However, during both periods, observations were made of the growth of other crops, of water table levels, and of the effects of various cultivations and waterings on the different soils, and these have led to the introduction of considerable modifications of subsequent work, the results of which will be available in due course.

(A) DRY SEASON 1928–29.

2. WHEAT WATERING EXPERIMENT.

See Table No. 1.

	Yield per acre, threshed.	Odds that the difference is significant.
Average of 8 Standards watered every 7 days 	665	—
Average difference of 7 Treat- ments watered every 28 days	— 93·7 ± 81·5	7 : 1

Experimental waterings ceased on the 20th February and those after that date were on 24th February, 3rd March, 10th March, 14th March and 18th March, after which watering ceased as the wheat was ripening.

The points of interest here are the good yields obtained from the light soil plots (nearer to 18a) and the superiority over their neighbours of plots 3b–6b inclusive. It would appear that the drain, which replaces plots 5a and 5b, is responsible for this. Those heavy plots where drainage is poor, e.g. 10a–11b, gave poor yields.

The experiment as a whole proves little, but the points worthy of record are :—

- (a) Wheat grows well on light soil. Probably, though not certainly, this is because of better drainage.
- (b) Where it is grown on heavy soil drainage such as is achieved by open drains is most necessary.

- (c) Perhaps twenty-eight day watering intervals are too long on any soil: there is a possibility that some toxicity, which would be minimised by more frequent watering, occurs on heavy poorly drained lands where rice stubble and weeds have only recently been ploughed into the soil.

3. WHEAT WATERING EXPERIMENT.

See Table No. 2.

	Yield per acre, threshed.	Odds that the difference is significant.
Average of 7 standard watered once per week	642	—
Average difference of 6 treatments watered twice per week ...	— 30 ± 92.2	Nil.

Here a late watering test was attempted, the scheme being to water all plots every twenty-one days until the wheat came into head and after that to water standard plots once a week and treatment plots twice a week. Heading occurred about the 22nd February and the experimental waterings were then begun.

Considered as a unit this experiment shows nothing, but if it is considered as two, viz. plots 6a-12a (Heavy soil) and plots 12a-18a (Light soil), then the following tables result.

PLOTS 6A—12A (Heavy Soil).

	Yield per acre, threshed.	Odds that the difference is significant.
Average of 4 standards watered once per week	848	—
Average difference of 3 treatments watered twice per week ...	— 209.3 ± 145.5	12 : 1

PLOTS 12A—18A (Light Soil).

	Yield per acre, threshed.	Odds that the difference is significant.
Average of 4 standards watered once per week	566	—
Average difference of 3 treatments watered twice per week ...	+ 149 ± 113.0	10 : 1

These indications, and statistically they are nothing more, show what would be naturally expected, but they do indicate that the watering during the later stages of growth is important and that every individual piece of land must be considered separately, a state of affairs which always obtains with the native who really farms, as his holdings are generally of small extent.

4. GUINEA-CORN (Masakwa?) Flat v. Ridge.

See Table No. 3.

	Yield per acre, threshed.	Odds that the difference is significant
Average of 9 standards on flat ...	657.4	—
Average difference of 8 treat- ments on ridge	+ 102.5 ± 67.5	14 : 1

The seed for this experiment was obtained from Bornu, and does not appear to be of the variety *masakwa* which was requested.

The generally accepted principle that it is better to grow on the ridge than on the flat seems to be borne out, but the real value of this test was that it is shown to be possible to grow a guinea-corn crop entirely out of season. The average yield would have been much higher had not small birds eaten a lot of the grains.

The chief reason why the natives do not grow guinea-corn on irrigable land during the dry season is that they expect birds to take a heavy toll: thus they find "underground" crops such as sweet potatoes or cassava more profitable. Wheat, being bearded, appears not to be devoured by birds. Perhaps, then, a bearded guinea-corn or gero would do well in the dry season.

(B) RAINY SEASON, 1929.

5. The Marabawa flood bank was completed in July, about three months later than was originally expected. This was due to the sudden invaliding of the Irrigation Engineer and consequent break in continuity.

Records of water levels were kept as in 1928 and show that there was a higher level inside the protected area in 1929 and that the water remained on the land some three weeks longer.

At the time of his invaliding nobody understood the scheme as well as the Irrigation Engineer, and his several successors each had a most difficult task in endeavouring to take over control during the most awkward period of the year. It is anticipated that conditions in 1930 will approximate much more to those of 1928, as at least two officers of this Department are now conversant with the Irrigation Engineer's original plans and have made a thorough study of the area concerned.

6. For the purpose of this report, it suffices to say that the persistence of the flood for the extra three weeks was a cause of considerable trouble in harvesting of rice.

7. RICE—EARLY WATERING EXPERIMENT.

See Table No. 4.

	Yield per acre, threshed.	Odds that the difference is significant.
Average of 8 Standards given light early watering ...	1917	—
Average difference of 7 treatments given heavy early watering ...	+ 27.4 ± 175.4	Nil.

Twenty days after planting extra water was begun on the treatment plots. The application of this extra water was subject to rainfall and it was only applied on four days altogether. At this time the "regulator valve" on the up-stream side of the measuring weir had not been installed, but the extra water applied to the treatments was approximately equal to 10" of rain. The rice on heavy soil was apparently being overwatered and treatment was stopped. Early in July the drain level rose after one very heavy rain but then fell slightly and it only refilled towards the end of the month. As it overflowed the water gradually invaded the lower plots. Further rises occurred steadily until the 9th October when the final fall began.

8. RICE—VARIETY TEST.

See Table No. 5.

	Yield per acre, threshed.	Odds that the difference is significant.
Average of 15 standards Tattara ...	1,128	—
Average difference of 5 treatments Guiana Creole ...	— 464.2 ± 133.0	4,350 : 1
Average difference of 5 treatments Maliya ...	— 1.6 ± 133.0	Nil.
Average difference of 4 treatments Guiana 75 ...	— 460.0 ± 148.7	1,030 : 1

In these results the experiences of the previous season on Block B1, 20b—32b seem to be more or less repeated. Maliya was the best treatment in either case, saving itself on both occasions with one good plot, though it was also less inferior on the others each time.

9. RICE—VARIETY TEST.

See Table No. 6.

	Yield per acre, threshed.	Odds that the difference is significant.
Average of 15 standards Jatau ...	1,265	—
Average difference of 5 treatments Guiana Creole ...	— 434.4 ± 113.0	15,000 : 1
Average difference of 5 treatments Maliya ...	+ 2.4 ± 113.0	Nil.
Average difference of 4 treatments Guiana 75 ...	— 433.0 ± 126.3	3,500 : 1

This yields very similar results to the last experiment. What does seem extraordinary is that Guiana Creole, which did very well on A1, 1a—18a, compares so poorly with these low-yielding standards.

10. RICE—MANURE EFFECTS—EXPERIMENT.

See Table No. 7.

	Yield per acre, threshed.	Odds that the difference is significant.
Average on 17 standards after Green Manure	1,296.9	—
Average difference on 8 treatments with No Manure	— 117 $\pm$ 131.3	5 : 1
Average difference on 8 treatments with 3 tons per acre F.Y.M. ...	+ 22.5 $\pm$ 131.3	Nil.

In the standard plots the mucuna first failed to germinate. On the occasion of the second sowing some seed was broadcast and ploughed in; another method tried was "plough, broadcast, harrow." The former seems the better method on hard soil as it seems to be the only way to get the seed well covered except by hand cultivation.

On the sandy plots mucuna was excellent. It steadily deteriorated towards the northern heavy soil plots, and on the first seven standards (1a—8a) there was hardly any growth. Where the mucuna grew well we found it difficult to plough in—perhaps not enough water was used, but a green manure of spreading habit like mucuna does not appear ideal.

11. RICE—BROADCAST *v.* TRANSPLANT—EXPERIMENT.

See Table No. 8.

	Yield per acre, threshed.	Odds that the difference is significant.
Average of 14 standards broadcasted	1,012.3	---
Average difference of 13 treatments transplanted	— 778.8 $\pm$ 78.1	∞ : 1

The rows of transplants were one foot apart, which was, in the light of present knowledge, too much. Six inches would have been better. Even so the transplants were distinctly poor. The seedlings were in the nursery for under four weeks which was not long enough. At the actual operation, transplanting was carried out by dibbling in the seedlings and then watering heavily. Compare Block B2, 19a—32b.

It is evident that we have much to learn in the matter of transplanting if we are to achieve yields such as are of common occurrence in the East; in this respect Mr. Sampson's visit was a very welcome one.

12. RICE—EARLY WATERING EXPERIMENT.

See Table No. 9.

	Yield per acre, threshed.	Odds that the difference is significant.
Average of 8 standards given light early watering	1,319.0	—
Average difference of 7 treatments given heavy early watering ...	+ 97.7 $\pm$ 64.0	15 : 1

(This was an experiment comparable to that on Block A1, 1a—18a).

The treatments received five extra waterings, between 29th May and 11th June. It was then considered that the rice would die if the treatments were not discontinued. It was not until late July that they looked at all satisfactory.

Plot 4b, which is outstanding, gave a poor yield last year.

13. RICE—BROADCAST *v.* TRANSPLANT—EXPERIMENT.

See Table No. 10.

This is a similar experiment to that described in paragraph 11 and Table No. 8. In that case Guiana Creole was used, in this **Jatau**.

	Yield per acre, threshed.	Odds that the difference is significant.
Average of 14 standards broadcasted	1,569.1	—
Average difference of 13 treatments transplanted	— 447.7 $\pm$ 47.3	c o : 1

The average decrease of the treatments compared with standards here is 28.5 *per cent.* compared with 77.0 *per cent.* in the companion experiment mentioned above. Transplanting distances were the same in both cases.

Jatau appeared to be a much better tillerer and most of the transplants looked very satisfactory, the only trouble being that there were not enough stands per plot.

Before the actual transplanting to these treatment plots water was applied and the soil thoroughly puddled, and levelled. In the case of plots 20a, 21a to 27a the work was done by hand, in 28a to 32a by cattle with a levelling board.

14. *Botanist's Plot.*—Fifty-two randomised strains were sown in thirteen newly laid out plots.

These varieties were all transplanted to rows 3 feet apart, stands 15 inches apart in the rows, two seedlings to a stand.

Exhaustive reports were sent to the Botanist as to the progress of these strains.

Further tests with the best of the above and with other exotics are to be made in 1930, when we expect to be able to control the water very exactly.

15. *Rainfall.* (See Table No. 11).—This appears to have been normal and well distributed month by month. A heavy tornado of 2'82" on the 2nd July had the effect of sending up the water level in the drain to 31'5" on the 4th. The level fell very slowly during July as the Officer in charge of Irrigation works was then installing the outlet culverts and flap gates and was obliged to erect a temporary earthen dam on either side and to pump continually to facilitate his work.

16. *Cattle.*—These number twenty, of which twelve work regularly. Of the other eight four will be broken in to regular work early in 1930, and the remaining four, which are not full grown, will be given light work occasionally.

The health of the animals has been good except that a scab known locally as "gurje," otherwise "kurji" or "kirchi," has troubled a few beasts. This scab has been very persistent and does not yield readily to treatment.

TABLE No. 1.
WHEAT WATERING EXPERIMENT.

Block & Plot.	Treatment.	Yield per acre.		Increase (+) or decrease (-) of 7 day waterings as compared with 28.
A.1.				
1a		568		
1b	7 day intervals ...		608	
2a		592		
2b	28 " " ...		584	-136
3a		544		
3b	7 " " ...		832	
4a		816		
4b	28 " " ...		776	0
6a		808		
6b	7 " " ...		720	
7a		472		
7b	28 " " ...		336	-260
8a		472		
8b	7 " " ...		472	
9a		472		
9b	28 " " ...		552	+80
10a		464		
10b	7 " " ...		472	
11a		312		
11b	28 " " ...		296	-144
12a		256		
12b	7 " " ...		408	
13a		456		
13b	28 " " ...		456	-148
14a		672		
14b	7 " " ...		800	
15a		904		
15b	28 " " ...		856	-48
16a		976		
16b	7 " " ...		1,008	
17a	—	1,336		
17b	—	1,304		
18a	—	1,288		

TABLE No. 1—*continued*.

Variety sown :—Sokoto Native Wheat. Each plot 1/16 acre.

Plot 17b and all the (a) plots were non-experimental water "buffer" plots watered every 28 days, *i.e.* when the whole field was watered.

Sown 24th December, 1928. Harvested 28th March, 1929.

Increase (+) or decrease (−) of 7 day
waterings as compared with 28.

− 136

0

− 260

+ 80

− 144

− 48

Mean − 93.7 ± 81.5 lb. per acre.

Root—mean—square—difference between neighbouring control plots = 215.6.

Cost of cultivation in man-days per acre = 166.

TABLE No. 2.

WHEAT—LATE WATERING EXPERIMENT.

Block & Plot.	Treatment.	Yield per acre.	Increase (+) or decrease (-) of treatment compared with mean of adjacent standards.
A2. 3a	Once a week when in head	704	
6b			
7a	Twice „ „ „ „ „	496	- 252
7b			
8a	Once „ „ „ „ „	792	
8b			
9a	Twice „ „ „ „ „	616	- 148
9b			
10a	Once „ „ „ „ „	736	
10b			
11a	Twice „ „ „ „ „	296	- 228
11b			
12a	Once „ „ „ „ „	312	
12b			
13a	Twice „ „ „ „ „	392	+ 32
13b			
14a	Once „ „ „ „ „	408	
14b			
15a	Twice „ „ „ „ „	744	+ 188
15b			
16a	Once „ „ „ „ „	704	
16b			
17a	Twice „ „ „ „ „	1,000	+ 228
17b			
18a	Once „ „ „ „ „	840	

Variety sown :—Sokoto Native Wheat. Each plot 1/16 acre.

Until the wheat came into head all plots watered every 21 days.

All (b) plots were non-experimental water "buffer" plots watered every 7 days, i.e. when the whole field was watered, after wheat came into head.

Sown 25th December, 1928. Harvested 30th March, 1929.

Increase (+) or decrease (-)
of twice per week waterings
compared with once per week.

- 252

- 148

- 228

+ 32

+ 188

+ 228

Mean — 30 ± 92.2 lb. per acre.

Root—mean—square —difference between neighbouring control plots=225.8.

Cost of cultivation in man-days per acre=183.

TABLE No. 3.
GUINEA-CORN (MASAKWA). FLAT *versus* RIDGE.

Block and Plot.	Treatment.				Yield per acre.	Increase (+) or decrease (-) of ridge as compared with Flat.
E 2. 8 <i>b</i>	Flat	...	...	...	688	
9 <i>a</i>		Ridge	...	...	1,120	+ 368
<i>b</i>	Flat	...	...	...	816	
10 <i>a</i>		Ridge	...	...	912	- 16
<i>b</i>	Flat	...	...	...	1,040	
11 <i>a</i>		Ridge	...	...	1,024	+ 24
<i>b</i>	Flat	...	...	...	960	
12 <i>a</i>		Ridge	...	...	1,072	+ 296
<i>b</i>	Flat	...	...	...	592	
13 <i>a</i>		Ridge	...	...	584	+ 96
<i>b</i>	Flat	...	...	...	384	
14 <i>a</i>		Ridge	...	...	432	+ 16
<i>b</i>	Flat	...	...	...	448	
15 <i>a</i>		Ridge	...	...	392	+ 32
<i>b</i>	Flat	...	...	...	272	
16 <i>a</i>		Ridge	...	...	240	+ 4
<i>b</i>	Flat	...	...	...	200	

Variety sown:—Reputed "masakwa" from Bornu. Each plot 1/16 acre.

Sown December, 1928, transplanted out 9th February, 1929.

Harvested 27th May, 1929 and ratooned.

Increase (+) or decrease (-)
of Ridge as compared with Flat.

+ 368
- 16
+ 24
+ 296
+ 96
+ 16
+ 32
+ 4

Mean + 102·5 = 67·5 lb. per acre.

Root—mean—square—difference between neighbouring control plots = 191·0.

Cost of cultivation in man-days per acre = 113.

TABLE No. 4.

RICE—EARLY WATERING EXPERIMENT.

Block and Plot.	Treatment.	Yield per acre.		Increase (+) or decrease (—) of heavy early waterings compared with light.
A 1. 1a	Light	1,616	1,376	
1b		1,616	1,808	+ 156
2a	Heavy	1,624	1,928	
2b		2,576	2,304	+ 452
3a	Light	1,848	1,776	
3b		1,656	1,680	— 100
4a	Heavy	2,192	1,784	
4b		2,224	2,080	+ 64
5a	Light	2,256	2,248	
5b		1,920	1,960	— 148
6a	Heavy	2,128	1,968	
6b		1,984	1,864	+ 40
7a	Light	2,056	1,680	
7b		2,080	1,856	— 272
8a	Heavy	2,728	2,576	
8b		2,568	2,160	
9a	Light	2,096		
9b				
10a				
10b				
11a				
11b				
12a				
12b				
13a				
13b				
14a				
14b				
15a				
15b				
16a				
16b				
17a				
17b				
18a				

Variety sown :—Guiana Creole. Each plot 1/16 acre.

Sown broadcast 17th May, 1929. Harvested 29th October, 1929.

Plot 17b and all (a) plots were non-experimental water "buffer" plots watered only when the "lightly watered" plots were due, *i.e.* when the whole field was watered.

Increase (+) or decrease (—)
of Heavy early waterings
compared with light.

+ 156
+ 452
— 100
+ 64
— 148
+ 40
— 272

Mean + 27·4 ± 175·4 lb. per acre.

Root—mean—square—difference between neighbouring control plots = 464·1.

Cost of cultivation in man-days per acre = 205.

TABLE No. 5.

RICE—VARIETY TEST.

Block and Plot.	Variety.	Yield per acre.		Increase (+) or decrease (-) of Guiana Creole, Maliya and Guiana 75 compared with.
A1. 19a	Tattara	1,384		
b	Tattara	1,082		
20a	Guiana Creole		560	— 381
b	Tattara	800		
21a	Maliya		960	— 72
b	Tattara	1,264		
22a	Guiana		1,824	+ 376
b	Tattara	1,632		
23a	Guiana Creole		1,360	— 180
b	Tattara	1,448		
24a	Maliya		1,376	— 8
b	Tattara	1,320		
25a	Guiana 75		656	— 600
b	Tattara	1,192		
26a	Guiana Creole		576	— 572
b	Tattara	1,104		
27a	Maliya		1,024	— 48
b	Tattara	1,040		
28a	Guiana Creole		216	— 916
b	Tattara	1,224		
29a	Guiana Creole		712	— 516
b	Tattara	1,232		
30a	Maliya		1,456	+ 316
b	Tattara	1,048		
31a	Guiana Creole		224	— 700
b	Tattara	800		
32a	Guiana Creole		328	— 672
b	Tattara	1,200		
33a	Maliya		672	— 196
b	Tattara	536		

Varieties sown:—As above. Each plot 1/16 acre.

Sown broadcast 19th May, 1929. Harvested 1st to 12th November, 1929.

Increase (+) or decrease (-) of
Guiana Creole compared
with Tattara.

— 381
— 180
— 572
— 516
— 672

Increase (+) or decrease (-) of
Maliya compared with
Tattara.

— 72
— 8
— 48
+ 316
— 196

Mean — 464.2 ± 133.0 lb. per acre.

Mean — 1.6 ± 133.0 lb. per acre.

TABLE No. 5—*continued*.

Increase (+) or decrease (−) of
Guiana 75 compared with
Tattara.

+ 376
− 600
− 916
− 700

Mean — 460·0 ± 148·7 lb. per acre.

Root—mean—square—difference between neighbouring control plots = 297·4.

Cost of cultivation in man-days per acre = 236.

TABLE No. 6.

RICE—VARIETY TEST.

Block and Plot.	Variety.	Yield per acre.	Increase (+) or decrease (−) of G. Creole, Maliya and G. 75, compared with Jatau.
A2. 19a	Jatau	1,808	
19b	Jatau	1,840	
20a	Guiana Creole	1,536	— 16
20b	Jatau	1,264	
21a	Maliya	1,552	0
21b	Jatau	1,840	
22a	Guiana 75	1,872	+ 152
22b	Jatau	1,600	
23a	Guiana Creole	1,152	— 360
23b	Jatau	1,424	
24a	Maliya	1,296	— 88
24b	Jatau	1,344	
25a	Guiana 75	728	— 592
25b	Jatau	1,296	
26a	Guiana Creole	696	— 504
26b	Jatau	1,104	
27a	Maliya	1,152	+ 56
27b	Jatau	1,088	
28a	Guiana 75	576	— 584
28b	Jatau	1,232	
29a	Guiana Creole	520	— 600
29b	Jatau	1,008	
30a	Maliya	976	— 56
30b	Jatau	1,056	
31a	Guiana 75	296	— 708
31b	Jatau	952	
32a	Guiana Creole	288	— 692
32b	Jatau	1,008	
33a	Maliya	1,064	+ 100
33b	Jatau	920	

TABLE No. 6—*continued*.

Variety sown:—As above. Each plot 1/16 acre.

Sown broadcast 21st May, 1929. Harvested 31st October–11th November, 1929.

Increase (+) or decrease (–) of Guiana Creole compared with Jatau.	Increase (+) or decrease (–) of Maliya compared with Jatau.
– 16	0
– 360	– 88
– 504	+ 56
– 600	– 56
– 692	– 100
Mean –434·4 ±113·0 lb. per acre.	Mean +2·4 ± 113·0 lb. per acre.

Increase (+) or decrease (–) of
Guiana 75 compared with Jatau.

+ 152
– 592
– 584
– 708

Mean – 433·0 ± 126·3 lb. per acre.

Root—mean—square difference between neighbouring control plots=252·7.

Cost of cultivation in man-days per acre=239.

TABLE No. 7.

RICE—MANURIAL EFFECT EXPERIMENT.

Block and Plot.	Treatment.	Yields per acre.		Increase (+) or decrease (−) of "nil" and "F.Y.M." plots compared with "mucuna green manure" plots.
B1. 1a	After Mucuna green manure ...	1,016		
1b	None	1,160	— 72	
2a	After Mucuna green manure ...	1,448		
2b	3 tons F.Y.M. per acre ...	1,928	+ 396	
3a	After Mucuna green manure ...	1,616		
3b	None	1,520	— 96	
4a	After Mucuna green manure ...	1,616		
4b	3 tons F.Y.M. per acre ...	1,488	+ 176	
6a	After Mucuna green manure ...	1,008		
6b	None	832	— 384	
7a	After Mucuna green manure ...	1,424		
7b	3 tons F.Y.M. per acre ...	672	— 384	
8a	After Mucuna green manure ...	688		
8b	None	1,184	+ 352	
9a	After Mucuna green manure ...	976		
9b	3 tons F.Y.M. per acre ...	912	— 152	
10a	After Mucuna green manure ...	1,152		
10b	None	1,024	— 248	
11a	After Mucuna green manure ...	1,392		
11b	3 tons F.Y.M. per acre ...	1,248	— 48	
12a	After Mucuna green manure ...	1,200		
12b	None	944	— 448	
13a	After Mucuna green manure ...	1,584		
13b	3 tons F.Y.M. per acre ...	1,344	— 24	
14a	After Mucuna green manure ...	1,152		
14b	None	944	— 112	
15a	After Mucuna green manure ...	960		
15b	3 tons F.Y.M. per acre ...	1,312	+ 80	
16a	After Mucuna green manure ...	1,504		
16b	None	1,664	+ 72	
17a	After Mucuna green manure ...	1,680		
17b	3 tons F.Y.M. per acre ...	1,792	+ 136	
18a	After Mucuna green manure ...	1,632		

Variety sown :—Guiana Creole. Each plot 1/16 acre.

Sown broadcast 18th May, 1929. Harvested 30th October and 1st November, 1929.

Increase (+) or decrease (−) of
"nil" plots compared with
"mucuna green manure" plots.

— 72
— 96
— 384
+ 352

Increase (+) or decrease (−) of
"F.Y.M." plots compared with
"mucuna green manure" plots.

+ 396
+ 176
— 384
— 152

TABLE 7—*continued.*

- 248	- 48
- 448	- 24
- 112	+ 80
+ 72	+ 136

Mean - 117.0 ± 131.3 lb. per acre.Mean + 22.5 ± 131.3 lb. per acre.

Root—mean -square— difference between neighbouring control plots—371.4.

Cost of cultivation in man-days per acre=198.

TABLE No. 8.

RICE—BROADCAST *versus*—TRANSPLANTED.

Block and Plot.	Treatment.	Yield per acre.	Increase (+) or decrease (-) of transplants compared with broadcasts.
B1. 19a	Broadcasted	1,120	
19b	Broadcasted	1,328	
20a	Transplanted	512	-804
20b	Broadcasted	1,304	
21a	Transplanted	608	-706
21b	Broadcasted	1,324	
22a	Transplanted	528	-690
22b	Broadcasted	1,112	
23a	Transplanted	312	-876
23b	Broadcasted	1,264	
24a	Transplanted	208	-908
24b	Broadcasted	968	
25a	Transplanted	136	-1,008
25b	Broadcasted	1,320	
26a	Transplanted	152	-844
26b	Broadcasted	672	
27a	Transplanted	56	-548
27b	Broadcasted	536	
28a	Transplanted	32	-700
28b	Broadcasted	928	
29a	Transplanted	24	-768
29b	Broadcasted	656	
30a	Transplanted	48	-644
30b	Broadcasted	728	
31a	Transplanted	144	-724
31b	Broadcasted	1,008	
32a	Transplanted	112	-904
32b	Broadcasted	1,024	

TABLE No. 8—*continued*.

Variety sown :—Guiana Creole. Each plot 1/16 acre.

Broadcast plots sown 26th May 1929.

Seed for transplanting sown nursery 16th May, transplanted 10th–13th June, 1929.

Harvested, plots 19a–20b on 30th October, others on 11th November, 1929.

Increase (+) or decrease (–) of
transplants compared with
broadcasts.

-- 804

-- 706

-- 690

-- 876

-- 908

-- 1,008

844

-- 548

-- 700

-- 768

-- 644

-- 724

-- 904

Mean -- 778·8±78·1 lb. per acre.

Root—mean—square—difference between neighbouring control plots=281·5.

Cost of cultivation in man-days per acre=176.

TABLE No. 9.

RICE EARLY WATERING EXPERIMENT.

Block and Plot.		Treatment.				Yield per acre.		Increase (+) or decrease (-) of heavy early waterings compared with light.	
B 2.	1a	Light	...	...	...	936		1,048	
	b								
	2a	Heavy	...	...	...	816		1,168	- 12
	b								
	3a	Light	...	...	...	1,376		1,312	
	b								
	4a	Heavy	...	...	...	1,392		1,720	+ 436
	b								
	6a	Light	...	...	...	912		1,256	
	b								
	7a	Heavy	...	...	...	1,424		1,440	+ 216
	b								
	8a	Light	...	...	...	1,368		1,192	
	b								
	9a	Heavy	...	...	...	1,296		1,312	+ 16
	b								
	10a	Light	...	...	...	1,288		1,400	
	b								
11a	Heavy	...	...	...	1,376		1,408	+ 48	
b									
12a	Light	...	...	...	1,360		1,320		
b									
13a	Heavy	...	...	...	1,088		1,456	+ 12	
b									
14a	Light	...	...	...	1,328		1,568		
b									
15a	Heavy	...	...	...	1,488		1,480	- 32	
b									
16a	Light	...	...	...	1,600		1,456		
b									
17a					1,432				
b					1,024				
18a					1,304				

Variety sown :—Jatau. Each plot 1/16 acre.

Sown broadcast 17th May. Harvested 28th and 29th October, 1929.

Plot 17b and all (a) plots were non-experimental water "buffer" plots watered on when the "lightly" watered plots were due, *i.e.*, when the whole field were watered.

Increase (+) or decrease (-) of heavy
early waterings compared
with light.

- 12
+ 436
+ 216
+ 16
+ 48
+ 12
- 32

Mean + 97.7 = 64.0 lb. per acre.

Root—mean square—difference between neighbouring control plots = 169.3.

Cost of cultivation in man-days per acre = 227.

TABLE No. 10.
RICE—BROADCASTED *versus* TRANSPLANTED.

Block and Plot.	Treatment.	Yield per acre.	Increase (+) or decrease (–) of transplants compared with broadcasts.
B2.—19a	Broadcasted	1,320	
19b	Broadcasted	1,368	
20a	Transplanted	1,000	– 564
20b	Broadcasted	1,760	
21a	Transplanted	1,280	– 544
21b	Broadcasted	1,888	
22a	Transplanted	1,664	– 184
22b	Broadcasted	1,808	
23a	Transplanted	1,176	– 456
23b	Broadcasted	1,456	
24a	Transplanted	1,384	– 120
24b	Broadcasted	1,552	
25a	Transplanted	976	– 592
25b	Broadcasted	1,584	
26a	Transplanted	1,000	– 544
26b	Broadcasted	1,504	
27a	Transplanted	1,552	+ 88
27b	Broadcasted	1,424	
28a	Transplanted	1,240	– 244
28b	Broadcasted	1,544	
29a	Transplanted	1,080	– 396
29b	Broadcasted	1,408	
30a	Transplanted	1,040	– 412
30b	Broadcasted	1,496	
31a	Transplanted	632	– 920
31b	Broadcasted	1,608	
32a	Transplanted	656	– 932
32b	Broadcasted	1,568	

Variety sown:—Jatau. Each plot 1/16 acre.

Broadcast plots sown 26th May.

Seed for transplanting sown nursery 16th May, transplanted 13th to 14th June, 1929.

Harvested 31st October and 11th November, 1929.

Increase (+) or decrease (–) of
transplants compared with broadcasts.

– 564

– 544

– 184

– 456

– 120

– 592

– 544

+ 88

– 244

– 396

– 412

– 920

– 932

Mean – 447·7±47·3 lb. per acre.

Root—mean—square difference between neighbouring control plots=170·5.

Cost of cultivation in man-days per acre=185.

TABLE No. 11.
RAINFALL, KWORRE, 1926-1929.

Month.	1926.	1927.	1928.	1929.	MEAN.
January ...	...	...	...	...	...
February ...	...	...	...	...	...
March ...	...	...	...	...	...
April ...	1·17	0·09	0·35	0·06	0·42
May ...	2·43	2·17	0·25	1·51	1·59
June ...	5·35	0·98	3·63	4·63	3·65
July ...	4·21	9·00	4·16	7·65	6·26
August ...	3·84	9·82	13·16	8·77	8·89
September ...	1·39	3·40	2·54	2·46	2·45
October ...	...	1·46	0·12	0·20	0·44
November ...	...	...	...	...	...
December ...	...	...	...	...	...
Totals ...	18·39"	26·92"	24·21"	25·28"	23·70"

TABLE No. 12.
RICE COSTING—1929.

	CALCULATED ON TOTAL AREA SOWN.		CALCULATED ON AREA ON WHICH CROP SUCCEEDED.	
	£	s. d.	£	s. d.
Preparation, including repairs to bunds and feeders ...	1	6 2	1	9 2
Sowing and Supplying, includ- ing transplanting where done	0	6 7	0	6 9
Cultivation, including watering	3	3 8	3	10 9
Harvesting, including carrying to high land in some cases	0	13 6	0	15 1
Store work, <i>i.e.</i> Threshing ...	0	7 8	0	8 8
Total costs ...	5	17 7	6	10 5

Cost per man-day=7d.

ANNUAL BULLETIN REPORT, AGRICULTURAL STATION, BADEGGI.

BY

A. G. BEATTIE.

The following Officers were in charge of the Station during the year :—

Mr. A. G. Beattie from 1st January to 6th June, 1929.

Mr. G. N. K. Turnbull from 7th June to 21st November, 1929.

Mr. A. G. Beattie from 22nd November to 31st December, 1929.

GENERAL.

Total area of Station	...	...	...	310 acres.
Total area under cultivation, 1929	...	...	...	103 acres.
Latitude	...	...	...	9° 0' N.
Longitude	...	...	...	6° 10' N.
Altitude	...	...	...	400' (approx.)

Mean (Bida) rainfall 1917-27 = 59·06 inches.

Distance from nearest point on coast = about 175 miles.

The site of the station was selected in 1928 and during that season the cropping was limited to ten acres of cotton for entomological observation. The soil is light, and of the type favoured locally for the growing of groundnuts. The soil lacks fertility on account of exhaustive previous cropping and failure to manure. Manuring of farms is practised only close to villages, of which there were none in the farm area.

A European house and outbuildings, also an office and labourers' village, all of mud construction, were completed before the beginning of the 1929 rains.

Rain fell on ninety-five days during the year, to a total of 54·84" which was lower than the average for the seasons 1917-27 at Bida.

Table No. 1 shows the monthly rainfall at Badeggi for 1929 and the comparative fall at Bida for an eleven year period.

CROPPING NOTES.

Cotton. All areas of cotton on the farm were very poor, suffering greatly from bollworms, stainers and subsequently bacterial disease. The whole crop was graded as N.A.3.

Groundnuts.—This was not a good season for groundnuts in Niger Province; many later planted areas being failures, possibly due to unsatisfactory distribution of rainfall. All groundnuts on the farm were planted comparatively early and were a better crop than the average of the district, although in some areas there was a large proportion of withered kernels.

Yams.—A large number of local varieties were grown on the plantation for observation of types. An area of mixed varieties grown on low land near a stream yielded 4,159 lb. per acre. Yams on higher ground grown with cotton yielded 2,128 lb. per acre. This appears a low yield but is thought to be up to the local average. The yams were planted at a spacing of 8 ft. by 8 ft. which is approximately that adopted by local farmers. Higher yields per acre will probably be obtained by closer spacing.

Guinea Corn.—A roughly average crop of guinea corn was obtained, though there were considerable variations in yield between one area and another. One area of $12\frac{1}{4}$ acres gave an average yield of 250 lb. of dry grain, per acre whereas the best plot on the farm yielded 900 lb. per acre.

Gero. This crop was a complete failure owing to very poor germination.

Maiwa.—This was also an average crop, $8\frac{1}{4}$ acres produced an average yield of 353 lb. dry grain per acre.

Rice.—Local farmers grow Maliya rice which was introduced from Ilorin by the Agricultural Department several years ago. This crop on the plantation did not yield up to the average obtained on the native rice plots.

The average on the plantation was 459 lb. per acre of dry grain; 700 lb. ought to be obtained quite easily.

EXPERIMENTS.

Cotton—Methods of Cultivation Test.

See Tables 2 and 2a.

To compare the yield and the costs of growing cotton on ridges with those of three common native methods—viz:—

- (I) Cotton on mounds with yams interplanted.
- (II) Cotton on mounds with maiwa interplanted.
- (III) Cotton alone on mounds.

The cotton planted on ridges made most rapid early growth, but later that planted alone on mounds was similar.

The cotton grown with maiwa was a complete failure, the plants being dwarfed and yielding barely one pound of cotton per plot. It may be concluded definitely that such a mixture is not feasible in this district.

Cotton grown with yams produced a much better vegetative growth than that with maiwa but the yield again was negligible and, when considered in conjunction with other plots of cotton and yams on the farm, there is a strong indication that this combination is also a failure. Further trials will be carried out. The yields are compared in Table No. 2. Table No. 2a is an analysis and summary of the relative costs and returns from the various methods of growing cotton.

It should be noted that the variety of cotton used for this experiment was Allen, and the fact that it cannot stand interplanting with other crops has already been confirmed both at Ilorin and Ibadan.

	Yields, cotton lb. per acre.	Odds that difference is significant.
Average yield of 13 control plots with cotton alone on ridges	103	
Average difference of 4 plots with maiwa ...	- 88.5 $\pm$ 14.25	∞ : 1
Average difference of 4 plots with yams ...	- 64.5 $\pm$ 14.25	∞ : 1
Average difference of 4 plots cotton alone on hills	- 24 $\pm$ 14.25	21 : 1

GROUNDNUTS, VARIETY TEST.

Table No. 3.

Local nuts, purchased in Zuafu market, were planted as standard and nuts from the following places were tested against them:—

Ilorin, Zaria, Zungeru.

The local Zuafu nuts have a widely spreading foliage; the Ilorin and Zaria nuts have a less markedly spreading habit. The Zungeru nuts had an upright habit of growth.

All the introduced varieties gave better yields than the local variety as shown in table No. 3.

It is considered desirable to repeat this experiment in 1930.

	Yields, kernels lb. per acre.	Odds that difference is significant.
Average yield of 13 control plots of Zuafu nuts	266	—
Average difference of 4 plots Ilorin nuts ...	+ 28 $\pm$ 28.7	5 : 1
Average difference of 4 plots Zaria nuts ...	+ 31.7 $\pm$ 28.7	5 : 1
Average difference of 4 plots Zungeru nuts ...	+ 15 $\pm$ 28.7	17 : 1

A small subsidiary test was carried out to observe if delaying the date of harvesting produced an effect on the yield. Accordingly a few plots outside the area of the variety test, but in a continuation of the same block were harvested a month later; the results are as follows:—

Average yield per acre (dry kernels) of thirteen plots of local nuts harvested 12.10.29 = 266 lb.

Average yield per acre of five plots of local nuts harvested 8.11.29 = 276 lb.

The difference is quite insignificant.

An experiment involving early and late harvesting for comparison of yields will be conducted in 1930.

Observations were also made on methods of decorticating groundnuts. The most rapid method of those tried was that of beating a heap of nuts with sticks. This method damaged the kernels much less than did the mortar and pestle method and thus made the subsequent separation of cortex by winnowing much easier.

RICE, VARIETY TEST.

Table No. 4.

A variety yield test was conducted, using the local Maliya as standard and comparing the yields of three varieties obtained from Sokoto, viz:—

Jatau, Guiana seventy-five, Guiana Creole.

The Jatau variety made much the most vigorous early growth and was ripe some time ahead of the others. This introduced an error from the point of view of comparative yield, as it had begun to shed its grain at the time of harvesting.

The Jatau variety gave a significantly and very considerably inferior yield to the Maliya whilst neither of the other two varieties appears significantly superior to Maliya.

The land selected for the rice experiment unfortunately proved extremely variable in quality, falling off rapidly in fertility from plot one to plot twenty-five.

	Yields, dry grain lb. per acre.	Odds that difference is significant.
Average yield of 13 control plots of local Maliya rice	459	—
Average difference of 4 plots Jatau	— 298 $\pm$ 71	33,300 : 1
Average difference of 4 plots Guiana 75	+ 2 $\pm$ 71	—
Average difference of 4 plots Guiana Creole	+ 48 $\pm$ 71	3 : 1

TABLE No. 1.

RAINFALL AT BADEGGI—1929 WITH COMPARATIVE RECORD.

Month.	No. of days on which Rainfell.	Total Rainfall for month.	Average per month 1917-1927 Bida Records.
January	...	...	Nil.
February	1	2.97"	.033"
March	3	1.16"	.907"
April	5	4.50"	3.573"
May	11	4.49"	8.030"
June	13	5.38"	8.290"
July	15	12.02"	10.265"
August	18	7.58"	8.925"
September	18	11.76"	13.968"
October	12	4.98"	4.495"
November	...	...	.581"
December	...	...	Nil.
	96 days	54.84"	59.07"

TABLE No. 2.

COTTON—METHOD OF CULTIVATION EXPERIMENT.

Plot.	Treatment.	YIELDS, LB. PER ACRE.			Maiwa. (threshed.)	Increase (+) or decrease (—) from means of adjacent controls (Cotton, lb.)
		Cotton.		Yams.		
		Control.	Treatment.			
1	Cotton alone, ridges ...	48				
2	Cotton and Maiwa ...		4		368	— 62
3	Cotton alone, ridges ...	84				
4	Cotton and Yams ...		48	2,636		— 50
5	Cotton alone, ridges ...	112				
6	Cotton alone, hills ...		64			— 24
7	Cotton alone, ridges ...	64				
8	Cotton and Maiwa ...		4		424	— 72
9	Cotton alone, ridges ...	88				
10	Cotton and Yams ...		44	2,364		— 52
11	Cotton alone, ridges ...	104				
12	Cotton alone, hills ...		96			— 96
13	Cotton alone, ridges ...	116				
14	Cotton and Maiwa ...		4		456	—118
15	Cotton alone, ridges ...	128				
16	Cotton and Yams ...		48	2,348		— 78
17	Cotton alone, ridges ...	124				
18	Cotton alone, hills ...		100			— 6
19	Cotton alone, ridges ...	88				
20	Cotton and Maiwa ...		4		340	— 94
21	Cotton alone, ridges ...	108				
22	Cotton and Yams ...		52	2,364		— 78
23	Cotton alone, ridges ...	152				
24	Cotton alone, hills ...		88			— 52
25	Cotton alone, ridges ...	128				

Root—Mean—Square—difference between neighbouring control plots = 28.5 lb. per acre.

Average yield of 13 control plots = 103 lb. per acre.

Increase (+) or decrease (-) of cotton on treatment plots, lb. per acre.

4 plots with Maiwa.

- 62
- 72
-118
- 94

4 plots with yams.

- 50
- 52
- 78
- 78

4 plots on hills.

- 24
- 14
- 6
- 52

Average - 88.5 ± 14.25

- 64.5 ± 14.25

- 24 ± 14.25

NOTES :—Size of plots, $\frac{1}{4}$ acre.

13 Control plots, stands 2 ft. apart on 4 ft. ridges.

4 plots with Maiwa, Cotton on hills 4 ft. × 8 ft., Maiwa 4 ft. apart on 4 ft. ridges.

4 plots with yams, Cotton on hills 4 ft. × 8 ft., yams on hills 8 ft. × 8 ft.

Cotton.—Planted June 28th, first picking November 12th.

Maiwa.—Planted May 31st, harvested November 18th.

Yams.—Planted May 16th, harvested October 31st.

TABLE No. 2A.

COTTON—METHOD OF CULTIVATION EXPERIMENT.

Relative costs and Returns from various methods of
growing Cotton.

Treatment.	Cost per acre.	Men-days per acre.	Yield per acre lb.	Price per lb.	Return per acre.	Return per man-day.	Profit or Loss per acre.
	£ s. d.				£ s. d.		£ s. d.
Cotton alone on ridges	1 11 0	60	103	1·5d.	0 12 10	2·56d.	Loss 0 18 2
COTTON AND MAIWA.							
Cotton	1 1 9	43	15	1·5d.	0 1 10½	...	...
Maiwa	1 1 0	42	397	·3d.	0 10 0	...	...
Total	2 2 9	85	...	...	0 11 10½	1·7d.	Loss 1 10 10½
COTTON AND YAMS.							
Cotton	1 7 11	55	39	1·5d.	0 4 11	...	...
Yams	0 13 0	26	2,428	0·1d.	1 0 0	...	...
Total	2 0 11	81	...	...	1 4 11	3·7d.	Loss 0 16 0
Cotton alone on hills	1 2 11	64	79	1·5d.	0 9 11	2d.	Loss 0 13 0

SUMMARISED.

RETURN PER MAN-DAY.

Cotton alone on ridges	2·56d.
Cotton and Maiwa	1·7d.
Cotton and yams	3·7d.
Cotton alone on hills	2d.

TABLE No. 3.
GROUNDNUTS—VARIETY TEST.

Plot.	Variety.	YIELDS, LB. PER ACRE, KERNELS.		Increase (+) or Decrease (–) from means of adjacent controls.
		Controls.	Treatments.	
1	Local, Zuafu	388		
2	Ilorin		384	+ 56
3	Local, Zuafu	268		
4	Zaria		304	+ 36
5	Local, Zuafu	268		
6	Zungeru		312	+ 24
7	Local, Zuafu	308		
8	Ilorin		288	– 44
9	Local, Zuafu	356		
10	Zaria		336	+ 38
11	Local, Zuafu	240		
12	Zungeru		304	+ 66
13	Local, Zuafu	236		
14	Ilorin		256	+ 15
15	Local, Zuafu	246		
16	Zaria		248	+ 31
17	Local, Zuafu	188		
18	Zungeru		280	+ 80
19	Local, Zuafu	212		
20	Ilorin		292	+ 84
21	Local, Zuafu	204		
22	Zaria		256	+ 22
23	Local, Zuafu	264		
24	Zungeru		280	+ 10
25	Local, Zuafu	276		

Root—Mean—Square—difference between neighbouring control plots = 57.5 lb. per acre.

Average yield of 13 control plots = 266 lb. per acre.

Increase (+) or decrease (–) of varieties on treatment plots, lb. per acre.

4 plots Ilorin nuts.

+ 56

– 44

+ 15

+ 84

4 plots Zaria nuts.

+ 36

+ 38

+ 31

+ 22

4 plots Zungeru nuts.

+ 24

+ 66

+ 80

+ 10

Average + 28 ± 28.7

+ 31.7 ± 28.7

+ 45 ± 28.7

NOTES :—Size of plots $\frac{1}{4}$ acre.

Planted 1 foot apart on 4 ft. ridges, 2 rows on a ridge, staggered.

Planted May 24th, harvested October 12th.

TABLE No. 4.
RICE—VARIETY TEST.

Plot.	Variety.	YIELDS, LB. PER ACRE DRY GRAIN.		Increase (+) or decrease (−) from means of adjacent controls.
		Controls.	Treatments.	
1	Local, Maliya	752		
2	Jatau		496	320
3	Local, Maliya	880		
4	Jatau		432	384
5	Local, Maliya	752		
6	Jatau		256	328
7	Local, Maliya	416		
8	Jatau		336	160
9	Local, Maliya	576		
10	Guiana 75		560	+ 16
11	Local, Maliya	512		
12	Guiana 75		490	—
13	Local, Maliya	480		
14	Guiana 75		416	+ 8
15	Local, Maliya	336		
16	Guiana 75		320	+ 16
17	Local, Maliya	336		
18	Guiana Creole		240	32
19	Local, Maliya	208		
20	Guiana Creole		256	+ 72
21	Local, Maliya	192		
22	Guiana Creole		320	+ 64
23	Local, Maliya	320		
24	Guiana Creole		352	+ 88
25	Local, Maliya	208		

Root -Mean-Square—difference between pairs of neighbouring control plots = 142.3 lb. per acre.

Average yield of 13 control plots = 459 lb. per acre.

Increase (+) or decrease (−) of yield of varieties on treatment plots.

4 plots Jatau.

320
− 384
− 328
− 160

4 plots Guiana 75.

+ 16
...
+ 8
− 16

4 plots Guiana Creole.

32
+ 72
+ 64
+ 88

Average − 298 ± 71

+ 2 ± 71

+ 48 ± 71

NOTES :—Size of plots 1/16 acre.

Ridges 2 ft. apart ; 2 rows of plants 18 inches apart on sides of ridges.

Not transplanted. Very thick stands were thinned.

Planted June 27th, harvested November 14th.

ANNUAL BULLETIN REPORT, YANDEV PLANTATION,
BENUE PROVINCE, 1929.

Mr. I. E. James was in charge of the Station during the year.

Investigations and experiments on the principal Munshi crops with a view to studying the native practices and to introducing improved methods of cultivation and improved varieties have been continued this year on the same lines as in the past. Special importance was attached to the work of developing a suitable rotation of continuous cropping which can be recommended to the local farmers to replace their present method of shifting cultivation. Three rotations, A, B, and C are at the present time, being experimented with (see Table No. 1. on a large scale, while various other rotations are under observation on a small scale. Rotation A was commenced in 1927 and although no definite conclusion can be arrived at as yet, there are distinct indications that it is sound and that the fertility of the soil is being maintained. The best yields of the main local crops, yams, millet, guinea-corn, benniseed and cotton, were obtained this season from Experimental Blocks under this rotation. Its superiority over the other rotations was to be expected as the latter were commenced more recently and have not yet received any green manuring, but it is satisfactory to note that it compares very favourably with the local Munshi methods. Rotation B commenced in 1928 is very similar to the general rotation practised by the Munshi farmers except that the period of four to seven years reversion to bush is replaced by one-and-half years green manuring. This rotation should prove successful as far as upkeep of fertility is concerned, but it is possibly not one which is likely to appeal to the native farmers as he will not take the trouble to prepare and plant up his old land with a bean crop which will occupy the land for one-and-half years and give no return in food in the meantime. In rotation C, the green manures are distributed more evenly amongst the crops, so that a food or commercial crop is obtained each year, and the soil fertility should be easily maintained.

In our 1927 Report, it was anticipated that sword grass (*Imperata Cylindrica Beauv*) might cause great difficulty in continuous cropping, but the *Mucuna* used as green manure has successfully smothered this weed.

The rainfall for the year was low, being 42.94 inches as compared to 60.63 inches in 1928 and 54.19 inches in 1927. Very little rain fell until the 10th May, so that difficulty was experienced

on both the plantation and native farms in establishing the millet, groundnuts, maize and benniseed crops. The severe drought in July was very beneficial for the harvesting of the benniseed and millet crops but made the establishment of the cotton and guinea-corn crops difficult. The total low rainfall was detrimental to the yam crop, the principal food crops of the Munshis and poor yields were general in the district.

Selection of the local Munshi variety of cotton was continued and it is hoped that a good quality cotton suitable to this locality will soon be evolved.

YAMS-- TIME OF PLANTING.

(See Table No. 2.)

				Yield in lb. per acre.	Odds difference is significant.
Average yield of 10 plots planted					
17th January	...	...	...	11,394	
Average difference 5 plots planted					
23rd March	...	...	...	3,259±596	∞ : 1
Average difference 4 plots planted					
25th May	...	...	...	8,871±667	∞ : 1

The Munshi farmers plant their yams either in January or April-June and the proportion seems to depend on the time that they have available for preparing the heaps in November-December before the soil becomes too hard. No effort, however, appears to be made to prepare as much land as possible during this period, as they know they can complete the yam farms in April to June. The above experiment, the results of which are nearly identical with those of a similar experiment in 1928, shows definitely that it is advisable to prepare all the land and to plant the crop as early as possible. It is also clearly established that early planted yams are more severely damaged by the Beetle (*Heteroligus Claudius*) than late planted, but this is probably due to the early yams acting as a trap crop and so saving the late yams from damage. A yield of 11,394 lb. per acre, during a season of very little rainfall, can be considered exceedingly high. On most native farms in the vicinity the yields, this year, are poor and the yams very small and the same applies to our own farms where we have planted on "bush" land according to the Munshi custom. The reason of this high yield is probably due to the good soil and its increased fertility due to green manuring with *Mucuna* during the latter part of the previous year, but the experiment shows that however good the soil, good yam yields cannot be obtained from it unless planted early.

MILLET—PLANTING ON SIX FEET RIDGES *versus*
SOWING BROADCAST.

(See Table No. 3.)

	Yield of grain in lb. per acre.	Odds difference is significant.
Average yield 10 plots 6 feet ridges	508	—
Average difference 9 plots broadcast	+ 108±43	160 : 1

Sowing broadcast is quite common in the south-east of Munshi country, but the practice in this area is to plant the millet on old consolidated yam heaps. The Entomologist thinks it possible that old yam heaps act as a breeding ground for the yam-beetle—a pest which has caused famine conditions here within recent years; and that by scattering the heaps, the eggs and larvæ are exposed to the sun and killed. The object of this experiment is to ascertain whether the introduction of broadcasting into this area will have any effect on the yields obtained. Better germination and a more even cover of the land was obtained on the broadcasted plots. All millet was slightly damaged by a small *Coleopterous* insect, while birds caused an appreciable amount of damage. The crop matured earlier than most others in the district, so that a large number of birds was attracted. The yield of 618 lb. of grain per acre off broadcasted plots can be considered high for this part of the country. The results indicate that broadcasting is the more economic method of growing millet in this area.

MILLET—VARIETY TRIAL. MUNSHI *versus* AWNED.

(See Table No. 4.)

	Yield of grain in lb. per acre.	Odds difference is significant.
Average yield 10 plots, Munshi millet	405	—
Average difference 9 plots Awned	— 118±43	190 : 1

The local variety of Munshi millet was tested against an awned variety obtained from Samaru. This latter millet has long awns which cover the spike and give it protection against bird damage. Bird damage is severe in Munshi country and a great deal of labour and care has to be taken in guarding the crop against attack during the period when it is in "head." The crops were established with difficulty owing to the drought conditions. No watchboys were employed on this Block and the birds caused a great deal of damage to the Munshi but the awned was not altogether immune. There was a great variation in the length of awns of the awned millet and some of the plants were nearly awnless. Selected varieties of awned millet have since been received from Samaru, and the most suitable of these will be tested against the local Munshi varieties. All local varieties are awnless.

MILLET AND GUINEA-CORN. SOWING GUINEA-CORN
THROUGH *versus* AFTER MILLET.

(See Table No. 5.)

	Yield of grain in lb. per acre.	Odds difference is significant.
Average yield 5 plots guinea-corn through millet	660 lb. combined grain.	
Average difference 4 plots guinea-corn after millet	— 251±70.2	4,350 : 1

In this district guinea-corn is sown on the same land as the millet crop, but not until after the latter has been harveted. This results in very poor yields of guinea-corn. The object of this experiment was to investigate the possibilities of planting the guinea-corn through the millet crop and the resulting effect on the combined yields of the two crops. Difficulty was encountered in establishing both the crops owing to drought conditions and the yields are not satisfactory. The experiment considered in conjunction with previous data on this problem, shows that increased yields are obtained by planting the guinea-corn through the millet and thus giving the former time to mature.

MILLET AND GUINEA-CORN. SIX FEET *versus*
THREE FEET RIDGES.

(See Table No. 6.)

	Yield of grain in lb. per acre.	Odds difference is significant.
Average yield 5 plots on 6 feet ridges	1,159 lb. combined grain.	
Average difference 4 plots on 3 feet ridges	— 42±76.7	3 : 1

Six feet and three feet ridges are in use on the plantation and the object of the above experiment was to determine the optimum size of ridges for millet and guinea-corn. The guinea-corn was planted through the millet crop. The millet gave poor yields while the guinea-corn was satisfactory on all plots. This result confirms the results of previous experiments and it can be concluded that there is nothing to choose between the two methods.

MILLET AND GUINEA-CORN.

Time of Planting Guinea-corn through Millet.

(See Table No. 7.)

	Yield of combined grain in lb. per acre.	Odds difference is significant.
Average yield 10 plots planted 7th June, 1929	1,195 lb.	—
Average difference 5 plots planted 29th June, 1929	— 264±77.1	4,350 : 1
Average difference 4 plots planted 12th July, 1929	— 294±86.2	4,350 : 1

Apart from the fact that the guinea-corn planted through millet gives superior yields to that planted after millet, very little is known regarding optimum time of planting guinea-corn. A good even crop of millet over the whole Block was produced; it was free from disease but suffered slight damage by birds. The late planted guinea-corn was established with difficulty owing to the July drought and the early planted was superior throughout the season. All plots were severely parasitized by *Striga Senegalensis*. Drought conditions usually occur in July and early August and it seems essential that the guinea-corn should be well established before that period. From the above experiment it appears that planting guinea-corn on 7th June is superior to planting later and next year experiments will be carried out to determine whether still earlier planting will be even more successful.

MAIZE VARIETY TRIAL.

(See Table No. 8).

	Yield of grain in lb. per acre.	Odds difference is significant.
Average yield 10 plots, Munshi	1,017	—
Average difference 5 plots, Lagos White	+ 22±54	—
Average difference 4 plots, Hickory King	+ 258±60	33,300 : 1

The Munshi maize was the ordinary maize grown locally, the Lagos white was received from Ibadan and the Hickory King was South African which had been grown on the plantation for one year. The germination was poor for all varieties and the final stand after supplying, was Munshi 59·8 *per cent.* Lagos white 76·2 *per cent.* and Hickory King 51·1 *per cent.* Munshi is a smaller plant than either of the others, so that, it was more handicapped by the poor stand. The Lagos white was superior up to the 13th June, 1929, when it became severely parasitized by the semi-parasite *Striga Senegalensis*. The other varieties suffered very little from this parasite. The Munshi was earlier maturing and this factor is of great importance in this district as maize is the first crop to be harvested and supplies food until the millet and yam crops are ready.

BENNISEED. CULTIVATION AND HARVESTING METHODS.

(See Table No. 9.)

	Yield in lb. seed per acre.	Odds difference is significant.
Average yield 10 plots Controls	505	—
Average difference 9 plots Test B. ...	— 18 ± 16·7	5 : 1

This experiment was carried out with a view to obtaining information on the most economic method, from a costings point of view, of producing benniseed. Two methods were tested out, namely (1) Controls. Benniseed planted on six feet ridges and harvested according to the local Munshi practice. (2) Tests. Sowing benniseed broadcast and harvesting according to the stooking method which has been introduced on the plantation. The latter method was known to be much cheaper but it was necessary also to know whether there would be any effect on the yields.

Good germination was obtained on the ridges but it was slightly patchy on the broadcasted plots. A few plants were destroyed by the drought in April, and by small black ants. The crop on all plots made excellent growth throughout the season, the weather conditions from May on, were ideal and the crop was free from disease and pests.

There is no appreciable difference in the yields and as the monetary returns per man-day are 6.4d. and 19.2d. respectively, it is apparent that the latter method is far more economic and if adopted locally should lead to increased acreages under this crop.

BENNISEED. THREE FEET RIDGES *versus* BROADCAST.

(See Table No. 10.)

	Yield in lb. seed per acre.	Odds difference is significant.
Average yield 10 plots 3 feet ridges ...	527	—
Average difference 9 plots broadcast ...	+ 35 ± 24	14 : 1

The plantation method of sowing benniseed on three feet ridges was tested against the local Munshi method of broadcasting. This experiment was carried out in 1927 and 1928 and there appeared to be very little difference in the yields obtained. This year the costings were fifty-eight man-days per acre for ridges and eighty-two and-a-half man-days per acre for broadcast. The preparation costs are greater for ridges but this is more than counter-balanced by the reduction in cost of harvesting.

The germination on all plots was good; broadcasting produced a uniform covering while there were only a few gaps on the ridges and these were supplied to produce an even cover. The crop made excellent growth throughout the season. The broadcast appeared to have produced a greater number of plants per acre than the ridges.

BENNISEED. METHOD OF HARVESTING.

(See Table No. 11.)

	Yield in lb. of seed per acre.	Odds difference is significant.
Average yield 5 plots Munshi method...	407	—
Average difference 4 plots stooking ...	+ 17 ± 26.7	3 : 1

This experiment is a repetition of one carried out last year and is an attempt to introduce a simpler and more economic method of harvesting the benniseed crop.

The Munshis harvest their benniseed in a very elaborate and laborious manner, by tying the benniseed heads into small bundles and placing these over rails to dry. By stooking the benniseed the cost of production would be greatly reduced. This experiment was carried out to determine the saving in labour and to find out whether the stooking method would have any effect on the yield. There is very little difference in the yields obtained and they agree with the results of a similar experiment in 1928. The costings this season are seventy-three man-days and forty-five man-days per acre respectively. Thus it is obvious from the above results that stooking is a great improvement on the local practice.

BENNISEED. SIZE OF RIDGES.

(See Table No. 12.)

	Yield in lb. seed per acre.	Odds difference is significant.
Average yield 5 plots 6 feet ridges ...	422	—
Average difference 4 plots 3 feet ridges	+ 60 ± 27	43 : 1

The costs of production of benniseed on six feet ridges and three feet ridges are the same so that the deciding factor will be the yields obtained. This experiment is a repetition of one carried out last season when three feet ridges gave superior yields.

Germination was fair and a good establishment was obtained by supplying. The crop from May onwards made excellent growth as the rains were heavy and well distributed and harvesting was carried out under ideal conditions during the July-August drought. No disease or pests attacked the crop during the growing period.

GROUNDNUTS. TIME OF PLANTING.

(See TABLE No. 13.)

	Yield of decorticated nuts per acre.	Odds difference is significant.
Average yield 10 plots planted 2nd April, 1929	846	—
Average difference 5 plots planted 17th April, 1929	- 52 ± 71.5	3 : 1
Average difference 4 plots planted 10th May, 1929	- 447 ± 80	α : 1

In 1928, Groundnuts planted on 2nd and 16th April gave little difference in yields while those planted on 8th May were much inferior and these results have been confirmed this year. The Munshi plant their groundnuts about 10th May and poor yields are nearly always the result. A certain amount of Rosette disease occurred on all plots and the diseased plants were rogued during June, but towards the end of the month there were too many plants slightly damaged to warrant any further roguing. The late planted were poor and stunted in growth throughout the season.

GROUNDNUTS. VARIETY TRIAL.

(See Table No. 14.)

		Yield of decorticated nuts per acre.	Odds difference is significant.
Average yield 5 plots, Munshi ...	...	687	—
Average difference 4 plots, Zaria ...	...	— 93 $\pm$ 24	4,350 : 1

The varieties tested were (a) Munshi groundnuts grown locally, (b) Zaria groundnuts obtained from Zaria. These varieties had previously been tested in 1927 and 1928 with the following results:—

1927 :—

Average yield 5 plots, Zaria ...	...	= 364 lb. undecorticated per acre.
Average difference 4 plots, Munshi ...	...	— 34.5 $\pm$ 37

1928 :—

Average yield 5 plots, Munshi ...	...	404 lb. undecorticated per acre.
Average difference 4 plots, Zaria ...	...	+ 82 $\pm$ 126

These yields were too low for the results to be considered reliable, but the indications are that there is little to choose between the two varieties. This year the yield of the variety of Zaria groundnuts experimented with is inferior to that of the local Munshi variety. It has been decided to discontinue planting the Zaria variety on this plantation. Next season other introduced varieties will be tested against the Munshi. The Munshi variety seemed more susceptible to Rosette disease, although both varieties had an appreciable number of plants affected.

GROUNDNUTS. SIX FEET RIDGES *versus* BEDS.

(See Table No. 15.)

		Yield of decorticated nuts per acre.	Odds difference is significant.
Average yield 5 plots six feet ridges ...	...	543	—
Average difference 4 plots beds ...	...	+ 193 $\pm$ 6.6	∞ : 1

When planting groundnuts on six feet ridges, full use does not seem to be made of the land and the above experiment was carried out to ascertain whether beds would give a better cover and yield. The Munshis plant their groundnuts on beds, but at too late a date to obtain a good crop. Rosette disease first appeared on the 4th June and by the end of that month was distributed fairly evenly over the whole Block. All diseased plants were rogued and burnt up to the end of June when too many plants were slightly attacked to continue doing so. A much better cover was obtained on beds. This experiment shows conclusively that beds are superior to six feet ridges and next season beds will be tested against three feet ridges.

GROUNDNUTS. SPACING ON SIX FEET RIDGES.

(See Table No. 16.)

		Yield of decorticated nuts per acre.	Odds difference is significant.
Average yield 5 plots Controls ...	...	617	—
Average difference 4 plots Test B.	...	- 112 $\pm$ 39.7	160 : 1

Groundnuts on six feet ridges on the plantation have previously been spaced at two rows per ridge, stands two feet apart, two seeds per stand and it was thought that closer spacing would give higher yields, so the following spacing was adopted on control plots: -three rows per ridge, stands two feet apart, two seeds per stand. All plots suffered from Rosette disease to the same extent.

MAIZE AND GUINEA-CORN. TEST CROPS AFTER ARRANGEMENT OF BENNISEED AND MUCUNA IN ROTATIONS.

(See Table Nos. 17 and 18.)

	Yield in lb. grain per acre.	Odds difference is significant.
<i>Maize</i> :—		
Average yield 5 plots after Benniseed followed by Mucuna ...	803	—
Average difference 4 plots after Mucuna followed by Benniseed... ..	+ 49 $\pm$ 167	—
<i>Guinea-corn</i> :—		
Average yield 5 plots after Benniseed followed by Mucuna	654	—
Average difference 4 plots after Mucuna followed by Benniseed	- 26 $\pm$ 46.9	—

In the 4th year of our Rotation A and the 3rd year of our Rotation B, benniseed is planted in April, harvested in August and followed by a cover crop of Mucuna beans in the same year. The Munshis generally plant their benniseed in April (early benniseed)

but in certain parts they plant in July (late benniseed). Either time would suit our rotations, so the deciding factors would be the yield of benniseed and the residual value. This experiment was commenced last year (1928) and much higher yields were obtained from the early benniseed. This year the residual values were tested by a crop of maize followed by guinea-corn. The control plots were after benniseed followed by mucuna and the test plots after mucuna followed by benniseed. Satisfactory yields were obtained from both crops and the indications are that there is no appreciable difference in the fertility of the control or test plots. Accordingly, owing to the higher yield of benniseed, the better order for the crops is benniseed followed by mucuna.

MAIZE AND GUINEA-CORN. TEST CROPS AFTER "BAMBARRA GROUNDNUTS *versus* CASSAVA *versus* SWEET POTATOES."

(See Table Nos. 19 and 20.)

	Yield of grain in lb. per acre.	Odds difference is significant.
<i>Maize :—</i>		
Average yield 10 plots after Bambarra G. nuts	783	—
Average difference 5 plots after cassava	— 99 ± 64	14 : 1
Average difference 4 plots after sweet potatoes	— 95 ± 71	8 : 1
<i>Guinea-corn :—</i>		
Average yield 10 plots after Bambarra G. nuts... ..	512	—
Average difference 5 plots after cassava	— 98 ± 55.4	24 : 1
Average difference 4 plots after sweet potatoes	— 42 ± 61.9	3 : 1

Bambarra groundnuts, cassava and sweet potatoes are grown locally on bush land and information about them would be useful should it be found necessary to substitute the yam crop temporarily by another food crop in the areas badly infested by yam beetle. The test was commenced in 1928 and this year test crops of maize followed by guinea-corn were grown to test the residual values. The monetary return per man-day from the three crops in 1928 were as follows :—

Bambarra Groundnuts	...	...	...	3.96d.
Cassava	...	...	...	8.49d.
Sweet Potatoes	...	...	...	9.75d.

The two latter are therefore much more profitable than the bambarra groundnuts.

The germination of the maize and guinea-corn was good so that no supplying was necessary. An appreciable number of plants was parasitized by *Striga Senegalensis*. Although Bambarra groundnuts have a less exhausting effect on the soil, their monetary return is so small compared to the other two crops, that the latter can be considered the more economic crops to grow.

MAIZE AND GUINEA-CORN. TEST CROPS AFTER "BAMBARRA
GROUNDNUTS *versus* BENNISEED *versus* GROUNDNUTS."

(See Table Nos. 21 and 22.)

Yield in lb. grain
per acre. Odds that difference
is significant.

Maize:—

Average yield 10 plots after Bambarra groundnuts	929	
Average difference 5 plots after benniseed	— 408 ± 110	4350 : 1
Average difference 4 plots after groundnuts	— 206 ± 124	21 : 1

Guinea-corn:—

Average yield 10 plots after Bambarra groundnuts	476	
Average difference 5 plots after benniseed	— 91 ± 57.4	17 : 1
Average difference 4 plots after groundnuts	+ .5 ± 64.2	—

Benniseed is the most important money crop in Munshi country and although groundnuts are not at present an important crop very heavy yields have been obtained on the plantation; so that the latter is a possible substitute for benniseed. Bambarra groundnuts have been grown recently on a very large scale by the Munshis as a food crop.

This experiment was commenced in 1928 and the monetary return per man-day favoured the Bambarra groundnuts. This year maize and guinea-corn were grown as test crops of residual values.

The data obtained indicates that Bambarra groundnuts are the most economic crop, but the yields of benniseed and groundnuts in 1928 were too low to place much reliance on the figures obtained. It appears that Bambarra groundnuts have a less exhausting effect on the soil than benniseed.

GUINEA-CORN.

TEST CROP FOR RESIDUAL VALUES OF GREEN MANURES.

(See Table No. 23.)

	Yield in lb. grain per acre.	Odds difference is significant.
Average yield 10 plots after mucuna	543	
Average difference 5 plots after mucuna + cowpeas	— 112 $\pm$ 32.9	4,350 : 1
Average difference 4 plots after pigeon peas	— 68 $\pm$ 36.8	27 : 1

In introducing green manuring into Munshi Agriculture the great difficulty will be to get the farmers to devote a whole year to a crop which produces no edible product. Mucuna is a very satisfactory green manure but it produces no edible beans, so in 1927 an experiment was commenced with the object of testing out edible beans against the mucuna. In 1928 test crops of millet and guinea-corn were grown and gave the following combined yields:—

After mucuna	871 lb. per acre.
After mucuna + Cowpeas	871 — 238 $\pm$ 94
After pigeon peas	871 — 66 $\pm$ 105

This year test crops of benniseed and guinea-corn were grown. The benniseed gave poor yields uniform over all plots, so has been discounted, while the guinea-corn yields support the previous results. Experiments are now being carried out to test the effect of planting mucuna as a full year crop, and as a catch crop in the same year as a food or commercial crop.

GROUNDNUTS *versus* BENNISEED RESIDUAL VALUES AND COSTINGS.

(See Table No. 24.)

Average yield 10 plots groundnuts = 1,182 lb. kernels per acre
 Average yield 9 plots benniseed = 539 lb. seed per acre.

This experiment was commenced in 1927 when groundnuts and benniseed were planted and gave yields of 1,995 lb. undecorticated groundnuts per acre and 376 lb. benniseed per acre. Expressed in monetary returns per man-day the groundnuts crop was distinctly more profitable. In 1928 a test crop of guinea-corn was grown with the following results:—

Average yield 10 plots after groundnuts ...	403 lb. grain
Average difference 9 plots after benniseed ...	+ 64 $\pm$ 17

This year the experiment was again commenced on the same Block, the crops occupying the same plots as they did in 1927 and high yields, as shown above, were obtained. The monetary return per man-day again favours the groundnut crop. Next year a test crop of maize will be grown to determine the residual values of these crops.

COTTON. TIME OF PLANTING MUNSHI COTTON.

(See Table No. 25.)

	Yield in lb. seed Cotton per acre.	Odds difference is significant.
Average yield 10 plots sown 15th June, 1929	145	
Average difference 5 plots sown 29th June, 1929	— 38 ± 14.9	160 : 1
Average difference 4 plots sown 15th July, 1929	— 108 ± 16.6	∞ : 1

The local farmers plant their cotton from June to August and appear to make no effort to plant during the early part of this period. In 1928 an experiment on the plantation showed definitely that better yields were obtained by planting the cotton on 3rd July than by planting on the 16th July or the 2nd August. This year still earlier dates were tested and again it is shown that the earlier planted gave the better yields.

The cotton plants made good growth up to early September when a severe Jassid attack occurred and the plants never recovered. Alternaria, Angular Leaf Spot and leaf curl were also present and an appreciable amount of bud and boll shedding took place.

COTTON VARIETY TRIAL. MUNSHI *versus* ISHAN A.

(See Table No. 26.)

	Yield in lb. seed cotton per acre.	Odds difference is significant.
Average yield 10 plots, Munshi	113	—
Average difference 9 plots, Ishan A. ...	+ 52 ± 8.1	∞ : 1

Cotton grown alone appears to be much more susceptible to diseases and pests than when grown through yams. The two varieties in this test, Munshi and Ishan A, were grown alone and suffered heavily from diseases and pests; Stainers and Leaf Spot (Alternaria) were common on both but the Munshi also suffered very severely from Jassids and it was this pest which was mainly responsible for the very low yield. Ishan A, appeared to be immune to this pest but was subjected to very heavy shedding of buds and bolls. Ishan A flowered earlier and produced a much higher number of buds per plant. The percentage of dirty lint was higher for Ishan A. Grown alone Ishan A appears to give higher yields than Munshi but both varieties have produced too low yields to be considered as economic crops when grown alone. To make cotton growing in this area a success it will probably be necessary to produce a selected Munshi cotton which is Jassid resistant.

COTTON THROUGH YAMS. TIME OF PLANTING MUNSHI COTTON.

(See Table No. 27.)

	Yield in lb seed cotton per acre.	Odds difference is significant.
Average yield 10 plots planted 8th June, 1929	127	—
Average difference 5 plots planted 22nd June, 1929	$- 29 \pm 10.4$	160 : 1
Average difference 4 plots planted 3rd July, 1929	$- 51 \pm 11.6$	33,300 : 1

The above result supports previous experiments on the same lines. Very poor yields of cotton are obtained in Munshi country and it is probable that one of the principal reasons is late planting. A yield of 127 lb. per acre appears low but actually such a yield is quite profitable owing to the very low cost of production of cotton when planted through yams.

The success of the cotton depends a great deal on the growth of the yam vines. If the latter are abundant then the cotton suffers and *vice versa*. An appreciable number of Stainers was present but caused very little staining as over ninety *per cent.* of the lint harvested was of good colour.

TABLE No. 1.

PRINCIPAL ROTATIONS ON PLANTATION.

Local Rotation.

- 1st year.—Yams interplanted with cotton, cowpeas, okra, etc.
- 2nd year.—Millet followed by guinea-corn.
- 3rd year.—Early benniseed.
- 4th to nth year.—Under “Bush” conditions.

Rotation A.

- 1st year.—Yams interplanted with beans.
- 2nd year.—Millet and guinea-corn.
- 3rd year.—Green manure followed by cotton.
- 4th year.—Benniseed followed by green manure.

Rotation B.

- 1st year.—Yams interplanted with cotton.
- 2nd year.—Millet and guinea-corn.
- 3rd year.—Benniseed followed by green manure.
- 4th year.—Green manure.

Rotation C.

- 1st year.—Yams interplanted with cotton.
- 2nd year.—Millet followed by green manure.
- 3rd year.—Green manure followed by guinea-corn.
- 4th year.—Benniseed followed by green manure.

TABLE NO. 2.

YAMS—TIME OF PLANTING.

No. of Plot.	Date planted.	Yield in lb. per acre.	Increase (+) or decrease (-) compared with mean of adjacent controls.
Block C3.			
Plot 1	17.1.29	14,236	
2	23.3.29	9,952	--3,586
3	17.1.29	12,840	
4	25.5.29	2,828	--9,830
5	17.1.29	12,416	
6	23.3.29	8,600	--3,738
7	17.1.29	12,260	
8	25.5.29	1,788	--9,986
9	17.1.29	11,288	
10	23.3.29	8,580	--2,012
11	17.1.29	9,896	
12	25.5.29	2,140	--8,778
13	17.1.29	11,940	
14	23.3.29	7,500	--3,214
15	17.1.29	9,488	
16	25.5.29	2,532	--6,890
17	17.1.29	9,356	
18	23.3.29	6,044	--3,746
19	17.1.29	10,224	

Each plot $\frac{1}{4}$ acre. Ridges 6 feet apart. Single sets 2 feet apart. 825 sets per acre.

Harvested 8th-10th January, 1930.

Average yield of 10 control plots planted 17th January, 1929 = 11,394 lb. per acre.
 Average decrease of 5 plots planted 23rd March, 1929 = - 3,259 $\pm$ 596
 " " " 4 " " 25th May, 1929 = - 8,871 $\pm$ 667
 Root—mean—square—difference between neighbouring control plots 1,333 lb. per acre.

Seed used. "Tops" of yams only.

Preceding crops :— 1927. Cotton.
 1928. Benniseed followed by Mucuna.

Average percentage of seed-yams to gross yield harvested :—

Planted 17th January, 1929	24.5%
" 23rd March, 1929	29.0%
" 25th May, 1929	45.0%

Average weight per 1,000 tubers :—

A. = 4,217 lb.
 B. = 3,208 lb.
 C. = 1,703 lb.

Monetary return per man-day :—

A. = 11.8d.
 B. = 8.4d.
 C. = 2.6d.

Percentage of yams attacked by Beetle (*Heteroligus Claudius*) :—

A. = 42.9%.
 B. = 29.5%.
 C. = 5.0%.

Labour pay on Plantation = 6d. *per diem*.

TABLE No. 3.

MILLET—PLANTING 6' RIDGES *versus* SOWING BROADCAST.

No. of Plot.	Treatment.	Yield in lb. grain per acre.	Increase (+) or decrease (–) compared with mean of adjacent controls.
Block C1.			
Plot 1	6 feet Ridges	714	
2	Broadcast	634	– 64
3	6 feet Ridges	682	
4	Broadcast	532	– 100
5	6 feet Ridges	582	
6	Broadcast	640	+ 191
7	6 feet Ridges	316	
8	Broadcast	656	+ 316
9	6 feet Ridges	364	
10	Broadcast	688	+ 306
11	6 feet Ridges	400	
12	Broadcast	736	+ 239
13	6 feet Ridges	594	
14	Broadcast	610	+ 87
15	6 feet Ridges	452	
16	Broadcast	530	+ 49
17	6 feet Ridges	510	
18	Broadcast	436	– 54
19	6 feet Ridges	470	

Each Plot $\frac{1}{4}$ acre. Controls. On 6 feet ridges, 1 row, stands 2 feet apart, 3 plants per stand.

Tests. Broadcasted over old yam ridges and ridges then scattered over seed.

Planted. Ridges. 3rd April, 1929.

Broadcast. 3rd April, 1929.

Harvested. Ridges. 8th July, 1929.

Broadcast. 2nd July, 1929.

Average yield 10 plots, on 6 feet ridges = 508 lb. grain per acre.

Average difference 9 plots Broadcast = + 108 $\pm$ 43.

Root $\cdot$ mean $\cdot$ square $\cdot$ difference between neighbouring control plots = 128 lb. per acre.

Preceding crops:— 1927. Benniseed followed by Mucuna.

1928. Yams.

Average percentage grain to head:— Ridges = 40%
Broadcast = 39.7%

Monetary return per man-day:— Ridges = 5.3d.
Broadcast = 6.5d

TABLE No. 4.

GERO—VARIETY TRIAL.—MUNSHI *versus* AWNED.

No. of Plot.	Variety.				Yield in lb. grain per acre.	Increase (+) or decrease (-) compared with mean of adjacent controls.
Block C6.						
Plot 1	Munshi	...	...	...	354	
2	Awned	...	...	...	336	— 126
3	Munshi	...	...	...	570	
4	Awned	...	...	...	400	— 115
5	Munshi	...	...	...	460	
6	Awned	...	...	...	342	— 182
7	Munshi	...	...	...	588	
8	Awned	...	...	...	292	— 273
9	Munshi	...	...	...	542	
10	Awned	...	...	...	230	— 248
11	Munshi	...	...	...	414	
12	Awned	...	...	...	298	— 127
13	Munshi	...	...	...	436	
14	Awned	...	...	...	314	— 90
15	Munshi	...	...	...	372	
16	Awned	...	...	...	316	+ 4
17	Munshi	...	...	...	252	
18	Awned	...	...	...	256	+ 97
19	Munshi	...	...	...	66	

Each plot $\frac{1}{4}$ acre. Munshi: On small mounds, 2 feet apart between 6 feet ridges, 3 plants per stand, 1 stand per mound.

Awned: On small mounds, 2 feet apart between heaps, 3 plants per stand, 1 stand per mound.

Planted. 2nd April, 1929.

Harvested. 11th July, 1929.

Average yield 10 plots Munshi = 405 lb. grain per acre.

Average difference 9 plots Awned = -118 ± 43 .

Root—mean—square—difference between neighbouring control plots = 128 lb. per acre.

Preceding crops :—

1927.—Bush.

1928.—Yams and Cotton.

Average percentage grain to heads :—

Munshi = 43%

Awned = 36%

Final stand establishment :

Munshi = 74.1%

Awned = 68.5%

Monetary return per man-day :—

Munshi = 6.8d.

Awned = 4.8d.

TABLE No. 5.

MILLET AND GUINEA-CORN.

SOWING GUINEA-CORN THROUGH *versus* AFTER MILLET.

No. of Plot.		Treatment.		Yield of grain in lb. per acre.	Increase (+) or decrease (—) compared with mean of adjacent controls.
Block	B2.				
Plot	1	Through	... ..	630	
	2	After	... ..	408	— 174
	3	Through	... ..	534	
	4	After	... ..	344	— 184
	5	Through	... ..	522	
	6	After	... ..	290	— 331
	7	Through	... ..	720	
	8	After	... ..	492	— 315
	9	Through	... ..	894	

Each plot $\frac{1}{4}$ acre. Millet:—Planted on 6 feet ridges, single row, stands 2 feet apart.

Guinea-corn:—Planted on 6 feet ridges, 2 rows, 2 feet between stands, 8 seeds per stand, thinned to 3 plants.

Millet:—Planted 2nd April, 1929. Harvested 19th July, 1929.

Guinea-corn:—Planted (A) 8th June, 1929 (B) 20th July, 1929.

Harvested:—21st December, 1929.

Average yield 5 plots controls=660 lb. combined grain.

Average difference 4 plots Test B. = -251 ± 70.2 .

Root—mean square—difference between neighbouring control plots=140.4.

Preceding crops:—

1927 Benniseed followed by Mucuna.

1928 Yams.

Percentage grain to heads:—

Millet:—Controls=41.5% Guinea-corn:—Controls=59.6%

Test B.=38.8% Test B.=44.2%

Monetary return per man-day.

Controls = 3.7d.

Test B. = 2.3d.

TABLE No. 6.

MILLET AND GUINEA-CORN.—6' *versus* 3' RIDGES.

No. of Plot.	Treatment.	Yield of grain in lb. per acre.	Increase (+) or decrease (—) compared with mean of adjacent controls.
Block B2.			
Plot 11	Six feet ridges ...	1,032	
12	Three feet ridges ...	1,034	— 80
13	Six feet ridges ...	1,196	
14	Three feet ridges ...	1,208	— 48
15	Six feet ridges ...	1,316	
16	Three feet ridges ...	1,264	— 10
17	Six feet ridges ...	1,232	
18	Three feet ridges ...	1,094	— 31
19	Six feet ridges ...	1,018	

Each plot $\frac{1}{4}$ acre. Millet :—6 feet ridges, 1 row, stands 4 feet apart.

3 feet ridges, 1 row, stands 8 feet apart.

Guinea-corn :—6 feet ridges, 2 rows, stands 2 feet apart.

3 feet ridges, 1 row, stands 8 feet apart.

Millet :—Planted 2nd April, 1929. Harvested :—19th July, 1929.

Guinea-corn :—Planted 10th June, 1929. Harvested :—21st December, 1929.

Average yield 5 plots 6 feet ridges 1,159 lb. combined grain.

Average difference 4 plots 3 feet ridges -42 ± 76.7 .

Root mean—square—difference between neighbouring control plots—153.4

Preceding crops :—

1927 Benniseed followed by Mucuna.

1928 Yams.

Percentage grain to heads.

Millet :—6 feet ridges=41.4% Guinea-corn :—6 feet ridges=60.7%

3 feet ridges=42.2% 3 feet ridges=60.9%

Monetary return per man-day :—

6 feet ridges=7.3d.

3 feet ridges=5.4d.

TABLE No. 7.

MILLET AND GUINEA-CORN. TIME OF PLANTING GUINEA-CORN THROUGH MILLET.

No. of Plot.	Date G. Corn Planted.	Yield of grain in lb. per acre.	Increase (+) or decrease (-) compared with mean of adjacent controls.
Block C7.			
Plot 1	7 6 29	1,238	
2	29 6 29	1,238	- 71
3	7 6 29	1,380	
4	12 7 29	1,294	- 85
5	7 6 29	1,378	
6	29 6 29	1,304	- 139
7	7 6 29	1,508	
8	12 7 29	1,040	- 296
9	7 6 29	1,164	
10	29 6 29	788	- 359
11	7 6 29	1,130	
12	12 7 29	720	- 385
13	7 6 29	1,080	
14	29 6 29	788	- 364
15	7 6 29	1,224	
16	12 7 29	724	- 408
17	7 6 29	1,040	
18	29 6 29	536	- 388
19	7 6 29	808	

Each plot $\frac{1}{4}$ acre. Millet planted on mounds between 6 feet ridges, mounds 2 feet apart, Samaru method.
Guinea-corn planted on top of 6 feet ridges, 1 row, stands 1 foot apart.

Millet planted 2nd April, 1929.

Harvested 10th July, 1929.

Guinea-corn planted (A) 7th June, 1929, (B) 29th June, 1929, (C) 12th July,

1929. Harvested 24th December, 1929.

Average yield 10 plots planted 7th June, 1929 = 1,195 lb. combined grain.

Average difference 5 plots planted 29th June, 1929 = -264 ± 77.1

Average difference 4 plots planted 12th July, 1929 = -294 ± 86.2

Root-mean-square difference between neighbouring control plots = 172.4.

Preceding crops:—1927. Bush.

1928. Yams and Cotton.

Percentage grain to heads:—

Millet:—		Guinea-corn:—	
Controls	'A' = 43.9%		64.2%
Test	'B' = 43.5%		58.1%
Test	'C' = 41.9%		57.9%

Monetary return per man-day:—

Controls	'A' = 7.8d.
Test	'B' = 6.1d.
Test	'C' = 5.9d.

TABLE No. 8.

MAIZE—VARIETY TRIAL.

No. of Plot.	Variety.	Yield of grain in lb. per acre.	Increase (+) or decrease (—) compared with mean of adjacent controls.
Block C9.			
Plot 1	Munshi	1,316	
2	Lagos white	1,588	+ 344
3	Munshi	1,172	
4	Hickory King	1,276	+ 196
5	Munshi	988	
6	Lagos white	904	— 142
7	Munshi	1,104	
8	Hickory King	1,356	+ 316
9	Munshi	976	
10	Lagos white	860	— 162
11	Munshi	1,068	
12	Hickory King	1,332	+ 306
13	Munshi	984	
14	Lagos white	976	+ 36
15	Munshi	896	
16	Hickory King	1,052	+ 214
17	Munshi	780	
18	Lagos white	864	+ 32
19	Munshi	884	

Each plot $\frac{1}{4}$ acre. Planted on 6 feet ridges, 2 rows, stands 2 feet apart, seed dibbled, 3 seeds per stand.

Date planted Munshi. 5th April, 1929, harvested 8th August, 1929.

Lagos white. 13th

Hickory King 14th

Average yield 10 plots Munshi ... = 1,017 lb. grain per acre.

Average difference 5 plots Lagos white = + 22 = 54

Average difference 4 plots Hickory King = - 258 = 60.5

Root-mean-square difference between neighbouring control plots = 127 lb. per acre.

Preceding crops:— 1927. Bush and old Guinea-corn farm.

1928. Groundnuts.

Average percentage grain to dry cobs:—

Munshi = 74.5%

Lagos white = 80.7%

Hickory King = 79.8%

Monetary return per man-day:—

Munshi = 3.4d.

Lagos white = 3.5d.

Hickory King = 4.2d.

TABLE No. 9.

BENNISEED—CULTIVATION AND HARVESTING METHOD.

No. of plot.	Treatment.						Yield in lb. per acre.	Increase (+) or decrease (—) compared with mean of adjacent controls.
Block B 9.								
Plot 1	A	...	...	...	...	...	503	
2	B	...	...	...	...	...	459	— 39
3	A	...	...	...	...	...	494	
4	B	...	...	...	...	...	433	— 90
5	A	...	...	...	...	...	552	
6	B	...	...	...	...	...	442	— 78
7	A	...	...	...	...	...	488	
8	B	...	...	...	...	...	474	— 20
9	A	...	...	...	...	...	501	
10	B	...	...	...	...	...	478	— 27
11	A	...	...	...	...	...	510	
12	B	...	...	...	...	...	560	+ 23
13	A	...	...	...	...	...	564	
14	B	...	...	...	...	...	561	+ 13
15	A	...	...	...	...	...	532	
16	B	...	...	...	...	...	519	+ 36
17	A	...	...	...	...	...	434	
18	B	...	...	...	...	...	469	+ 17
19	A	...	...	...	...	...	470	

Each plot $\frac{1}{4}$ acre.—Treatment A. Planted on 3 feet ridges, two rows, stands 1 foot apart, and harvested Munshi method.

Treatment B. Broadcasted on level land and harvested stooking method

Date planted 23rd April, 1929. Date harvested 2nd August, 1929.

Average yield 10 plots controls = 505 lb. seed per acre.

Average difference 9 plots Tests = -18 ± 17 .

Root—mean—square—difference between neighbouring control plots = 50 lb. per acre.

Preceding crops :— 1927. Gero and Guinea-corn.

1928. Mucuna followed by Cotton.

Percentage sand and dirt in seed :—

Controls = .03%

Tests = .96%

Monetary return per man-day :—

Controls = 6.4d.

Tests = 19.2d.

TABLE No. 10.

BENNISEED—3 FEET RIDGES *versus* BROADCAST.

No. of Plot.		Treatment.	Yield in lb. seed per acre.	Increase (+) or decrease (-) compared with mean of adjacent controls.
Block B 1.				
Plot	1	3 feet Ridges	674	
	2	Broadcast ...	653	+ 8
	3	3 feet Ridges	616	
	4	Broadcast ...	560	- 8
	5	3 feet Ridges	521	
	6	Broadcast ...	641	+ 97
	7	3 feet Ridges	567	
	8	Broadcast ...	516	+ 19
	9	3 feet Ridges	427	
	10	Broadcast ...	512	+ 84
	11	3 feet Ridges	430	
	12	Broadcast ...	512	+ 28
	13	3 feet Ridges	539	
	14	Broadcast ...	550	+ 34
	15	3 feet Ridges	493	
	16	Broadcast ...	487	- 9
	17	3 feet Ridges	499	
	18	Broadcast ...	564	+ 65
	19	3 feet Ridges	499	

Each plot $\frac{1}{4}$ acre.—Controls. On 3 feet ridges, 2 rows, stands 1 foot apart, thin to 3 plants per stand.

Tests.—Broadcasted Munshi method.

Date planted :—23rd April, 1929. Date harvested : 29th July, 1929.

Average yield 10 plots 3 feet ridges=527 lb. seed per acre.

Average difference 9 plots Broadcast = $+35 \pm 24.4$.

Root—mean—square—difference between neighbouring control plots -73 lb.
per acre.

Preceding crops :—1927.—Gero and Guinea-corn.

1928.—Mucuna followed by Cotton.

Monetary return per man-day :—

3 feet Ridges= 8.8d.

Broadcast = 6.6d.

TABLE No. 11.

BENNISEED—METHODS OF HARVESTING.

No. of Plot.	Method.	Yield in lb. seed per acre.	Increase (+) or decrease (—) compared with mean of adjacent controls.
Block B 5.			
Plot 1	Munshi	396	
2	Stooking	405	+ 31
3	Munshi	352	
4	Stooking	420	+ 33
5	Munshi	422	
6	Stooking	394	— 17
7	Munshi	400	
8	Stooking	452	+ 20
9	Munshi	464	

Each plot $\frac{1}{2}$ acre.—Munshi method. Tying in small bundles and hanging on fence.
 Stooking method.—Tying into sheaves of 4 per stook.

Date planted: 24th April, 1929. Date harvested:—1st August, 1929.

Average yield 5 plots Munshi method = 407 lb. seed per acre.

Average difference 4 plots Stooking method = $+17 \pm 26.7$.

Root—mean—square—difference between neighbouring control plots
 = 53.4 lb. per acre.

Preceding crops:—

1927.—Groundnuts.

1928.—Maize.

Percentage sand and impurities in seed:—

Munshi method 0.9%

Stooking method 1.37%

Monetary return per man-day:—

Munshi method = 5.4d.

Stooking method = 9.1d.

TABLE No. 12.
BENNISEED—SIZE OF RIDGES.

No. of Plot.	Ridges.	Yield in lb. seed per acre.	Increase (+) or decrease (—) compared with mean of adjacent controls.
Block B5.			
Plot 11	6 feet Ridges ...	360	
12	3 feet Ridges ...	517	+119
13	6 feet Ridges ...	436	
14	3 feet Ridges ...	488	+ 69
15	6 feet Ridges ...	402	
16	3 feet Ridges ...	451	+ 38
17	6 feet Ridges ...	424	
18	3 feet Ridges ...	468	+ 13
19	6 feet Ridges ...	486	

Each plot $\frac{1}{4}$ acre.—Controls. On 6 feet ridges, 3 rows, stands 1 foot apart,
3 plants per stand.

Tests.—On 3 feet ridges, 2 rows, stands 1 foot apart,
3 plants per stand.

Date planted :—24th April, 1929. Date harvested :—2nd August, 1929.

Average yield 5 plots 6 feet ridges = 422 lb. seed per acre.

Average difference 4 plots 3 feet ridges = $+60 \pm 26.8$.

Root—means—quare—difference between neighbouring control plots
= 53.6 lb. per acre.

Preceding crops :—

1927 Maize.
1928 Groundnuts.

Monetary return per man-day :—

6 feet ridges = 5.8d.

3 feet ridges = 6.7d.

TABLE No. 13.

GROUNDNUTS—TIME OF PLANTING.

No. of Plot.	Time planted.			Yield in lb. decorticated nuts.	Increase (+) or decrease (-) compared with mean of adjacent controls.	
Block A9.						
Plot 1	2/4/29	...	...	1,040		
2	17/4/29	...	...	860	-	134
3	2/4/29	...	...	948		
4	10/5/29	...	...	552		- 452
5	2/4/29	...	...	1,060		
6	17/4/29	...	...	936	-	110
7	2/4/29	...	...	1,032		
8	10/5/29	...	...	332		- 536
9	2/4/29	...	...	704		
10	17/4/29	...	...	772	+	14
11	2/4/29	...	...	812		
12	10/5/29	...	...	364		- 342
13	2/4/29	...	...	600		
14	17/4/29	...	...	656	-	34
15	2/4/29	...	...	780		
16	10/5/29	...	...	284		- 458
17	2/4/29	...	...	704		
18	17/4/29	...	...	744	+	2
19	2/4/29	...	...	780		

Each plot $\frac{1}{4}$ acre.—Method of cultivation. On 3 feet ridges, 2 rows, stands 2 feet apart, 2 seeds (decorticated) per stand.

Date harvested:—Controls 19th August, 1929.
 Test B 13th September, 1929.
 Test C 17th " "

Average yield 10 plots controls... .. = 846 lb. decorticated nuts/acre.
 Average difference 5 plots Test B = - 52 $\pm$ 71.5.
 " " 4 " " C = -447 $\pm$ 79.9.

Root--mean--square--difference between neighbouring control plots
 = 160 lb. per acre.

Preceding crops:—1927 Bush and old Guinea-corn farm.
 1928 Guinea-corn.

Percentage decorticated to dry undecorticated:—	Monetary return per man-day:—
Controls 55%	6.0d.
Test B 57%	5.4d.
Test C 53%	3.3d.

Seed planted per acre.	Seed supplied per acre.	Final stand establishment.
Controls = 25.1 lb.	10.5 lb.	78.6%
Test B = 25.2 lb.	6.4 lb.	77.8%
Test C = 27.5 lb.	8.5 lb.	71.5%

TABLE No. 14.

GROUNDNUTS—VARIETY TRIAL.

No. of Plot.	Variety.					Yield in lb. decorticated nuts per acre.	Increase (+) or decrease (—) compared with mean of adjacent controls.
Block B8.							
Plot 1	Munshi	...	...	...	...	632	
2	Zaria	...	...	...	...	684	+ 6
3	Munshi	...	...	...	...	724	
4	Zaria	...	...	...	...	588	—124
5	Munshi	...	...	...	...	700	
6	Zaria	...	...	...	...	588	—106
7	Munshi	...	...	...	...	688	
8	Zaria	...	...	...	...	540	—150
9	Munshi	...	...	...	...	692	

Each plot $\frac{1}{4}$ acre.—Method of cultivation. On 6 feet ridges, 3 rows, stands 2 feet apart 2 seeds (decorticated) per stand.

Date planted :—9th April, 1929.

Date harvested.—21st August, 1929

Average yield 5 plots Munshi = 687 lb. decorticated nuts per acre.

Average difference 4 plots Zaria = -93 ± 24 .

Root—mean—square—difference between neighbouring control plots
= 48 lb. per acre.

Preceding crops :—

1927 Maize followed by Canavalia.

1928 Benniseed followed by Canavalia.

Percentage decorticated to dry undecorticated :—

Munshi = 53%

Zaria = 47%

Seed Rate.

Supply Rate.

Munshi 18 lb. per acre.

8.5 lb. per acre.

Zaria 15 lb. per acre.

8 „ „ „

Monetary return per man-day.

Munshi 4.5d.

Zaria 4.1d.

TABLE No. 15.

GROUNDNUTS—6 FEET RIDGES *versus* BEDS.

No. of Plot.	Treatment.	Yield in lb. decorticated nuts per acre.	Increase (+) or decrease (–) compared with mean of adjacent controls.
Bkck. C8.			
Plot 1	6 feet Ridges	528	
2	Beds	812	+ 282
3	6 feet Ridges	532	
4	Beds	776	+ 236
5	6 feet Ridges	548	
6	Beds	692	+ 146
7	6 feet Ridges	544	
8	Beds	664	+ 110
9	6 feet Ridges	564	

Each plot $\frac{1}{4}$ acre.—Controls. On 6 feet ridges, 3 rows, stands 2 feet apart,
2 seeds (decorticated) per stand.

Tests.—On 11 feet Beds, 6 rows, stands 2 feet apart,
2 seeds (decorticated) per stand.

Date planted:—9th April, 1929. Date harvested:—22nd August, 1929.

Average yield 5 plots 6 feet ridges = 543 lb. decorticated nuts/acre.

Average difference 4 plots Beds = $+193 \pm 6.6$.

Root—mean—square—difference between neighbouring control plots
= 13.1 lb. per acre.

Preceding crops:—

1927 Bush and old Guinea-corn farm.
1928 Maize.

Percentage decorticated to dry undecorticated:—

6 feet ridges = 49%
Beds = 52%
Seed rate = 18 lb. per acre.
Supply rate = 11.3 lb. per acre.

Final stand Establishment:—

6 feet = 66.1%
Beds = 60.5%

Monetary return per man-day.

6 feet ridges = 3.9d.
Beds ... = 5.6d.

TABLE No. 16.

GROUNDNUTS—SPACING ON 6 FEET RIDGES.

No. of Plot.	No. of rows.				Yield in lb. Decorticated nuts per acre.	Increase (+) or decrease (—) compared with mean of adjacent controls.
Block C8						
Plot 11	3 rows	...	...	...	608	
12	2 rows	...	...	...	508	— 130
13	3 rows	...	...	...	668	
14	2 rows	...	...	...	508	— 104
15	3 rows	...	...	...	556	
16	2 rows	...	...	...	388	— 212
17	3 rows	...	...	...	644	
18	2 rows	...	...	...	624	— 2
19	3 rows	...	...	...	608	

Each plot $\frac{1}{4}$ acre.—Controls. On 6 feet ridges, 3 rows, stands 2 feet apart, 2 seeds (decorticated) per stand.

Tests. On 6 feet ridges, 2 rows, stands 2 feet apart, 2 seeds (decorticated) per stand.

Date planted 9th April, 1929. Date harvested 23rd August, 1929.

Average yield 5 plots 3 rows = 617 lb. decorticated nuts per acre.

Average difference 4 plots 2 rows = — 112 = 39.7

Root—mean—square—difference between neighbouring control plots = 79.3 lb. per acre.

Preceding crops :— 1927. Bush and old Guinea-corn farm.
1928. Maize.

Percentage decorticated to dry undecorticated :—

3 rows = 49%

2 rows = 50%

Seed rate.

Supply rate.

Final stand establishment.

3 rows = 17.3 lb. per acre.

10.7 lb. per acre.

65.3%

2 rows = 12.0 lb. per acre.

7.0 lb. per acre.

72.7%

Monetary return per man-day :—

3 rows = 4.3d.

2 rows = 3.7d.

TABLE No. 17.

MAIZE—TEST CROP AFTER “ARRANGEMENT OF BENNISEED AND
MUCUNA IN ROTATION.”

No. of Plot.	Treatment.	Yield in lb. grain per acre.	Increase (+) or decrease (—) compared with mean of adjacent controls.
Block A4			
Plot 3	A	498	
4	B	936	+ 337
5	A	700	
6	B	840	+ 80
7	A	820	
8	B	852	— 176
9	A	1,232	
10	B	954	— 44
11	A	764	

Each plot $\frac{1}{4}$ acre. Treatment A. After Benniseed followed by Mucuna in 1928.

Treatment B. After Mucuna followed by Benniseed in 1928.

Method of cultivation. All plots, on 6 feet ridges, 2 rows, stands 2 feet apart, staggered, 3 seeds per stand. Mass selected seed used.

Seed rate = 8·6 lb. per acre. Supply rate = 4·4 lb. per acre.

Date planted 4th April, 1929. Date harvested 15th July, 1929.

Average yield 5 plots after A = 803 lb. grain per acre.

Average difference 4 plots after B = + 49 ± 166·6

Root—mean—square—difference between neighbouring control plots =
333 lb. per acre.

Preceding crops:— 1927. Cotton

1928. Benniseed and Mucuna.

Percentage grain to dry cobs:—

Controls = 74·1%

Tests = 77·9%

Monetary return per man-day:—

Controls = 3·5d.

Tests = 3·7d.

TABLE No. 18.

GUINEA-CORN. TEST CROP AFTER

“ARRANGEMENT OF BENNISEED AND MUCUNA IN ROTATIONS.”

No. of Plot.	Treatment.			Yield in lb. grain per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
Block A4					
Plot 3	A ...	...	...	700	
4	B ...	...	...	600	− 72
5	A ...	...	...	644	
6	B ...	...	...	624	− 16
7	A ...	...	...	636	
8	B ...	...	...	672	+ 72
9	A ...	...	...	564	
10	B ...	...	...	560	− 86
11	A ...	...	...	728	

Each plot $\frac{1}{4}$ acre. Treatment A. After Benniseed followed by Mucuna (in 1928).

Treatment B. After Mucuna followed by Benniseed (in 1928).

Method of cultivation. On 6 feet ridges, 2 rows, stands 2 feet apart.

Seed rate = 4 lb. per acre.

Supply rate = 2.7 lb. per acre.

Planted 3rd August, 1929.

Harvested 19th December, 1929.

Average yield 5 plots A = 654 lb. grain per acre.

Average difference 4 plots B = − 26 ± 46.9

Root-mean-square-difference between neighbouring control plots = 93.8.

Preceding crops:— 1927. Cotton.

1928. Benniseed and Mucuna.

Percentage grain to heads:—

A = 57.2%

B = 58.9%

Monetary return per man-day:—

A = 6.9d.

B = 6.6d.

TABLE No. 19.

MAIZE—TEST CROP AFTER “BAMBARRA GROUNDNUTS
versus CASSAVA versus SWEET POTATOES.”

No. of Plot.	Treatment.				Yield in lb. grain per acre.	Increase (+) or decrease (–) compared with mean of adjacent controls.	
Block A10.							
Plot 1	A	...	...	...	716		
2	B	...	...	...	544	– 94	
3	A	...	...	...	560		
4	C	...	...	...	560		– 42
5	A	...	...	...	644		
6	B	...	...	...	692	– 30	
7	A	...	...	...	800		
8	C	...	...	...	736		– 98
9	A	...	...	...	868		
10	B	...	...	...	608	–234	
11	A	...	...	...	816		
12	C	...	...	...	808		–120
13	A	...	...	...	1,040		
14	B	...	...	...	896	– 94	
15	A	...	...	...	940		
16	C	...	...	...	700		–120
17	A	...	...	...	700		
18	B	...	...	...	680	– 44	
19	A	...	...	...	748		

Each plot $\frac{1}{4}$ acre.—Treatment A. After Bambarra Groundnuts (1928).

Treatment B. After Cassava (1928).

Treatment C. After Sweet Potatoes (1928).

Maize.—Method of cultivation. Planted on level ground, 6 sq. feet per stand, 2 seeds per stand.

Seed rate = 10 lb. per acre.

Variety used = Munshi.

Date planted:—11th May, 1929.

Date harvested:—1st August, 1929.

Average yield 10 plots. After A = 783 lb. grain per acre.

Average difference 5 plots. After B = -99 ± 63.8 .

Average difference 4 plots. After C = -95 ± 71.3 .

Root—mean—square—difference between neighbouring control plots

= 142.6 lb. per acre.

Preceding crops:—

1927 Bush.

1928 B.G. nuts, Cassava and Sweet Potatoes.

Percentage grain to dry cobs:—

Monetary return per man-day:—

A = 69.6%.

7.3d.

B = 69.7%.

6.1d.

C = 70.6%.

6.1d.

TABLE No. 20.

GUINEA-CORN.—TEST CROP AFTER “BAMBARRA GROUNDNUTS
versus CASSAVA versus SWEET POTATOES.”

No. of Plot.	Treatment.				Yield in lb. grain per acre.	Increase (+) or decrease (−) compared with mean of adjacent controls.
Block A10.						
Plot 1	A	...	...	...	588	
2	B	...	...	...	460	− 32
3	A	...	...	...	396	
4	C	...	...	...	396	− 50
5	A	...	...	...	496	
6	B	...	...	...	380	−182
7	A	...	...	...	628	
8	C	...	...	...	556	+ 6
9	A	...	...	...	472	
10	B	...	...	...	320	−126
11	A	...	...	...	420	
12	C	...	...	...	416	− 62
13	A	...	...	...	536	
14	B	...	...	...	480	− 84
15	A	...	...	...	592	
16	C	...	...	...	456	− 64
17	A	...	...	...	448	
18	B	...	...	...	428	− 66
19	A	...	...	...	540	

Each plot $\frac{1}{4}$ acre.—Treatment A. After Bambarra Groundnuts (in 1928).

Treatment B. After Cassava (in 1928).

Treatment C. After Sweet Potatoes (in 1928).

Guinea-corn.—Method of cultivation. Broadcast.—Local method.

Seed rate = 7·8 lb. per acre.

Planted:—9th August, 1929.

Harvested:—26th December, 1929.

Average yield 10 plots A = 512 lb. per acre.

Average difference 5 plots B = $-98 \pm 55\cdot4$.

Average difference 4 plots C = $-42 \pm 61\cdot9$.

Root-mean-square-difference between neighbouring control plots = 123·9.

Preceding crops:—

1927 Bush.

1928 B.G. nuts, Cassava, and Sweet Potatoes.

1929 Maize.

Percentage grain to heads:—

A = 54·8%.

B = 52·7%.

C = 54·9%.

Monetary return per man-day:—

A = 7·8d.

B = 6·3d.

C = 7·2d.

TABLE No. 21.

MAIZE—TEST CROP AFTER “BAMBARRA GROUNDNUTS
versus BENNISEED versus GROUNDNUTS.”

No. of Plot.	Treatment.				Yield in lb. grain per acre.	Increase (+) or decrease (—) compared with mean of adjacent controls.
Block C2.						
Plot 1	A	...	...	...	780	
2	B	...	...	...	324	— 334
3	A	...	...	...	536	
4	C	...	...	...	568	+ 10
5	A	...	...	...	580	
6	B	...	...	...	468	— 206
7	A	...	...	...	768	
8	C	...	...	...	864	— 96
9	A	...	...	...	1,152	
10	B	...	...	...	584	— 672
11	A	...	...	...	1,360	
12	C	...	...	...	600	— 554
13	A	...	...	...	948	
14	B	...	...	...	400	— 518
15	A	...	...	...	888	
16	C	...	...	...	848	— 184
17	A	...	...	...	1,176	
18	B	...	...	...	828	— 310
19	A	..	...	...	1,100	

Each plot $\frac{1}{4}$ acre. —Treatment A.—After Bambarra Groundnuts (1928).

Treatment B.—After Benniseed (1928).

Treatment C.—After Groundnuts (1928).

Maize.—Method of cultivation. Planted on level ground, 6 sq. feet per stand, 2 seeds per stand.

Variety used = Munshi.

Seed rate = 10 lb. per acre.

Date planted:—11th May, 1929.

Date harvested:—1st August, 1929.

Average yield 10 plots after A = 929 lb. grain per acre.

Average difference 5 plots after B = -408 ± 110.5 .

Average difference 4 plots after C = -206 ± 123.6 .

Root-mean-square-difference between neighbouring control plots
= 247 lb. per acre.

Preceding crops:—

1927 Cotton.

1928 B.G. nuts, Benniseed and
Groundnuts.

Percentage grain to dry cobs:—

A = 68.1%.

B = 69.0%.

C = 68.3%.

Monetary return per man-day.

6.0d.

3.4d.

4.7d.

TABLE No. 22.

GUINEA-CORN TEST CROP AFTER

"BAMBARRA GROUNDNUTS *versus* BENNISEED *versus* GROUNDNUTS."

No. of Plot.	Treatment.				Yield in lb. grain per acre.	Increase (+) or decrease (-) compared with mean adjacent controls.	
Block C2							
Plot 1	A	...	...	...	544		
2	B	...	...	...	420	—	40
3	A	...	...	...	376		
4	C	...	...	...	380		— 18
5	A	...	...	...	420		
6	B	...	...	...	360	—	64
7	A	...	...	...	428		
8	C	...	...	...	528		+ 32
9	A	...	...	...	564		
10	B	...	...	...	428	—	122
11	A	...	...	...	536		
12	C	...	...	...	560		+ 86
13	A	...	...	...	412		
14	B	...	...	...	316	—	194
15	A	...	...	...	608		
16	C	...	...	...	408		— 98
17	A	...	...	...	404		
18	B	...	...	...	400	—	34
19	A	...	...	...	464		

Each plot $\frac{1}{4}$ acre. Treatment A. After Bambarra Groundnuts (1928).

Treatment B. After Benniseed (in 1928).

Treatment C. After Groundnuts (in 1928).

Guinea-corn. Method of cultivation. Broadcast. Local method.

Seed rate = 7 lb. per acre.

Planted 9th August, 1929. Harvested 26th December, 1929.

Average yield 10 plots A = 476 lb. grain per acre.

Average difference 5 plots B = — 91 $\pm$ 57.4Average difference 4 plots C = + 5 $\pm$ 64.2

Root—mean—square— difference between neighbouring control plots = 128.5.

Preceding crops:— 1927. Cotton.

1928. B. G. Nuts, Benniseed and Groundnuts.

1929. Maize.

Percentage grain to heads:—

A = 60.4%

B = 58.9%

C = 60.5%

Monetary return per man-day:—

6.6d.

5.3d.

6.6d.

TABLE 23.

GUINEA-CORN. TEST CROP AFTER
 "MUCUNA v. MUCUNA FOLLOWED BY COWPEAS v. PIGEON PEAS."

No. of Plot.	Treatment.				Yield in lb. grain per acre.	Increase (+) or decrease (-) compared with mean of adjacent controls.	
Block B3							
Plot 1	A	...	...	...	452	— 56	
2	B	...	...	...	376		
3	A	...	...	...	412		
4	C	...	...	...	436	— 22	
5	A	...	...	...	504		
6	B	...	...	...	448		
7	A	...	...	...	536	— 72	
8	C	...	...	...	468		
9	A	...	...	...	564		
10	B	...	...	...	572	+ 14	
11	A	...	...	...	552		
12	C	...	...	...	540		
13	A	...	...	...	608	— 40	
14	B	...	...	...	412		
15	A	...	...	...	592		
16	C	...	...	...	428	— 128	
17	A	...	...	...	520		
18	B	...	...	...	344		
19	A	...	...	...	688	— 260	

Each plot $\frac{1}{4}$ acre. Treatment A. After Mucuna alone (in 1927).

Treatment B. After Mucuna followed by Cowpeas (in 1927).

Treatment C. After Pigeon Peas (in 1927).

Guinea-corn. Method of cultivation. Broadcast local method.

Seed rate = 7 lb. per acre.

Planted 15th August, 1929. Harvested 24th December, 1929.

Average yield 10 plots A.... .. = 543 lb. grain per acre.

Average difference 5 plots B = — 112 $\pm$ 32.9

Average difference 4 plots C = — 68 $\pm$ 36.8

Root—mean—square—difference between neighbouring control plots = 73.6

Preceding crops:— 1927. Mucuna, Cowpeas and Pigeon Peas.

1928. Millet and Guinea-corn.

1929. Benniseed.

Percentage grain to heads:—

Monetary return per man-day:—

A = 49.2%

9.5d.

B = 46.9%

7.6d.

C = 47.0%

8.3d.

TABLE No. 24.

GROUNDNUTS *versus* BENNISEED—RESIDUAL VALUE AND COSTINGS.

No. of Plot.	Crop.	Yield in lb. per acre.
Block A1		
Plot 1	Groundnuts	1,164
2	Benniseed	578
3	Groundnuts	1,200
4	Benniseed	560
5	Groundnuts	1,136
6	Benniseed	536
7	Groundnuts	1,320
8	Benniseed	432
9	Groundnuts	1,072
10	Benniseed	548
11	Groundnuts	1,088
12	Benniseed	498
13	Groundnuts	1,128
14	Benniseed	468
15	Groundnuts	1,184
16	Benniseed	611
17	Groundnuts	1,448
18	Benniseed	618
19	Groundnuts	1,076

Each plot $\frac{1}{4}$ acre.

Method of cultivation. Groundnuts. On 3 feet ridges, 2 rows, stands 2 feet apart, 2 seeds per stand.
 Benniseed. On 3 feet ridges, 2 rows, stands 1 foot apart, thin to three 3 plants per stand.

Date planted. Groundnuts 3rd April, 1929.
 " " Benniseed 23rd April, 1929.
 Date harvested. Groundnuts 16th August, 1929.
 " " Benniseed 6th August, 1929.

Average yield 10 plots Groundnuts — 1,182 lb. decorticated nuts/acre.
 Average yield 9 plots Benniseed — 539 lb. seed per acre.

Preceding crops:— Controls. 1927. Groundnuts.
 1928. Guinea-corn.
 Tests. 1927. Benniseed.
 1928. Guinea-corn.

Groundnuts. Decorticated to dry undecorticated = 65%

Monetary return per man-day:—

Groundnuts = 6'3d.
 Benniseed = 5'5d.

Labour pay on Plantation = 6d. per day.

TABLE No. 25.

COTTON—TIME OF PLANTING MUNSHI COTTON.

No. of Plot.		Date Planted.		Yield in lb. seed cotton per acre.	Increase (+) or decrease (—) compared with mean of adjacent controls.
Block A 2.					
Plot	1	15/6/29	... ..	178	
	2	29/6/29	... ..	157	— 25
	3	15/6/29	... ..	185	
	4	15/7/29	... ..	52	— 123
	5	15/6/29	... ..	164	
	6	29/6/29	... ..	90	— 39
	7	15/6/29	... ..	94	
	8	15/7/29	... ..	32	— 67
	9	15/6/29	... ..	103	
	10	29/6/29	... ..	87	— 34
	11	15/6/29	... ..	139	
	12	15/7/29	... ..	29	— 124
	13	15/6/29	... ..	166	
	14	29/6/29	... ..	125	— 30
	15	15/6/29	... ..	143	
	16	15/7/29	... ..	34	— 117
	17	15/6/29	... ..	158	
	18	29/6/29	... ..	76	— 62
	19	15/6/29	... ..	117	

Each plot $\frac{1}{4}$ acre. Planted on 6 ft. ridges, 2 rows, stands 4 ft. apart, 1 plant per stand.

Date harvested. 14th December, 1929 to 22nd March, 1930
(8 pickings)

Average yield 10 plots planted 15th June, 1929 ... = 145 lb. per acre.

Average difference 5 plots planted 29th June, 1929 ... = - 38 $\pm$ 14.9.

Average difference 4 plots 15th July, 1929 ... = - 108 $\pm$ 16.6.

Root—mean—square—difference between neighbouring control plots = 33.2.

Preceding crops:— 1927. Yams.

1928. Millet and Guinea-corn.

1929. Mucuna (April-June).

Average percentage dirty cotton to total yield:—

Controls = 18.8%

Test B = 20.4%

Test C = 11.6%

Seed rate.

Controls ... = 2.6 lb. per acre

Test B ... = 2.4 lb. per acre

Test C ... = 2.5 lb. per acre

Supply rate.

3.2 lb. per acre.

3.6 lb. per acre.

2.5 lb. per acre.

Monetary return per Man-day:—

Controls ... = 3.2d.

Test B ... = 2.3d.

Test C ... = .9d.

TABLE No. 26.

COTTON—VARIETY TRIAL. MUNSHI *versus* ISHAN A.

No. of Plot.		Variety.	Yield in lb. seed cotton per acre.	Increase (+) or decrease (—) compared with mean of adjacent controls.
Block A 3.				
Plot	1	Munshi	178	
	2	Ishan 'A'	214	+ 34
	3	Munshi	182	
	4	Ishan 'A'	212	+ 44
	5	Munshi	153	
	6	Ishan 'A'	186	+ 56
	7	Munshi	107	
	8	Ishan 'A'	162	+ 71
	9	Munshi	75	
	10	Ishan 'A'	135	+ 66
	11	Munshi	63	
	12	Ishan 'A'	107	+ 41
	13	Munshi	69	
	14	Ishan 'A'	132	+ 56
	15	Munshi	82	
	16	Ishan 'A'	103	+ 35
	17	Munshi	53	
	18	Ishan 'A'	127	+ 68
	19	Munshi	65	

Each plot $\frac{1}{4}$ acre. Planted on 6 ft. ridges, two rows, stands 4 ft. apart, one plant per stand.

Planted 24th June, 1929. Harvested 11th December, 1929 to 24th March, 1930.
(9 pickings)

Average yield 10 plots Munshi = 113 lb. seed cotton per acre.

Average difference 9 plots, Ishan 'A' = + 52 $\pm$ 8.1.

Root—mean—square—difference between neighbouring control plots = 24.3

Preceding crops:—
1927. Yams
1928. Millet and Guinea-corn
1929. Mucuna (April-June).

Average percentage dirty cotton to total yield.

Munshi	...	...	...	22.2%
Ishan 'A'	...	...	...	26.9%

Seed rate.
Munshi 2.4 lb. per acre
Ishan 'A' 3.1 lb. per acre

Supply rate.
2.2 lb. per acre.
4.1 lb. per acre.

Monetary return per man-day:—

Munshi	...	...	...	...	= 2.2d.
Ishan 'A'	...	...	...	...	= 3.1d.

TABLE No. 27.

COTTON—TIME OF PLANTING MUNSHI COTTON THROUGH YAMS.

No. of Plot.	Time of planting.	Yield in lb. seed cotton per acre.	Increase (+) or decrease (—) compared with mean of adjacent controls.
Block B11.			
Plot 1	8/6/29	186	
2	22/6/29	112	— 65
3	8/6/29	168	
4	3/7/29	103	— 47
5	8/6/29	131	
6	22/6/29	102	— 40
7	8/6/29	153	
8	3/7/29	76	— 57
9	8/6/29	112	
10	22/6/29	108	— 8
11	8/6/29	119	
12	3/7/29	44	— 63
13	8/6/29	95	
14	22/6/29	81	— 22
15	8/6/29	110	
16	3/7/29	70	— 38
17	8/6/29	105	
18	22/6/29	92	— 8
19	8/6/29	94	

Each plot $\frac{1}{4}$ acre. Planted through yam crop on East side of ridge, 6 ft. ridges, 1 row, stands 2 ft. apart, 1 plant per stand.

Harvested 20th December, 1929 to 25th March, 1930 (8 pickings).

Average yield 10 plots planted 8th June, 1929 = 127 lb. seed cotton per acre.

Average difference 5 plots planted 22nd June, 1929 = -29 ± 10.4 .

Average difference 4 plots planted 3rd July, 1929 = -51 ± 11.6 .

Root-mean-square-difference between neighbouring control plots = 23.2

Preceding crops:— 1927. Bush.

1928. Bush.

Average percentage dirty cotton to total yield:—

Controls	8.5%
----------	------

Test B = 6.9%

Test C = 3.8%

Seed rate.

Supply rate.

Controls ... 2.9 lb. per acre

2.9 lb. per acre.

Test A	...	2.5 lb. per acre
Test B	...	4.0 lb. per acre

3.0 lb. per acre.

Test C ... 2.0 lb. per acre

1.8 lb. per acre.

Monetary return per man-day :—

Controls = 7.0d.

Test B = 5.5d.

Test O = 4.4d.

TABLE No. 28.

COST OF CULTIVATION OF MAIN CROPS, 1929-30 SEASON
IN MAN-DAYS PER ACRE.

Crop.			Prepara- tion.	Sowing.	After Cul- tivation.	Harvest.	Miscellaneous.	Total Man- days per acre.
Yams	...	...	46·3	21·3	16·0	39·2	(a) 3·7	126·5
Millet	...	...	7·8	4·5	5·2	8·7	(a) 4·8	31·0
Guinea-corn	...	...	2·6	6·6	9·4	12·5	(a) 5	31·6
Maize	...	...	15·2	5·5	6·5	16·8	(a) 5·3	49·3
Benniseed	...	...	22·8	6·2	5·8	33·4	...	68·2
Groundnuts...	...	...	28·3	6·1	7·1	50·4	(b) 44·0	135·9
Cotton	...	...	16·6	7·0	10·0	7·2	...	40·8

(a) Cost of Watchboys.

(b) Cost of decorticating.

TABLE No. 29.

COMPARISON OF COST OF PRODUCTION AND REVENUE
FROM MAIN CROPS 1929-30 SEASON.

Crop.	Cost in man- days per acre.	Average yield per acre.	Cost of crop in man-days per lb.	Market va- lue per lb. (Local).	Calculated return per acre.
					£ s. d.
Yams Gross	126·5	8,027	·016	·125d.	4 3 7
do. Nett	126·5	5,176	·024	·125d.	2 13 11
Millet	31·0	437	·071	·446d.	0 16 3
Guinea-corn	31·6	579	·055	·429d.	1 0 8
Maize	49·3	859	·057	·259d.	0 18 6
Benniseed	68·2	411	·166	·964d.	1 13 0
Groundnuts	135·9	780	·174	1·071d.	3 9 8
Cotton	40·8	98	·416	1·500d.	0 12 3

Crop.	Monetary return per man-day.	Condition of Crop.
Yams Gross	7·93d.	Tubers as stored.
do. Nett	5·11d.	" " "
Millet	6·29d.	Grain.
Guinea-corn	7·85d.	"
Maize	4·50d.	"
Benniseed	5·80d.	Seed.
Groundnuts	6·15d.	Decorticated nuts.
Cotton	3·60d.	Seed Cotton.

Labour Pay on Plantation = 6d. per diem.

TABLE No. 30.
RAINFALL RECORD—YANDEV.

Month.	1927.		1928.		1929.	
	Rainfall inches.	No. of days of rain.	Rainfall inches.	No. of days of rain.	Rainfall Inches.	No. of days of rain.
January	·00	0	2·16	4	·00	0
February	·58	1	·00	0	·00	0
March	·36	1	3·72	8	·63	3
April	4·14	8	4·54	6	1·91	5
May	10·10	12	6·77	14	6·92	13
June	5·79	15	12·89	19	10·32	14
July	4·28	18	5·58	14	2·23	5
August	9·63	20	3·28	12	5·84	17
September	7·99	16	10·73	22	6·16	18
October	9·67	18	9·98	16	8·24	14
November	1·11	1	·11	3	·48	2
December	·54	1	·87	1	·21	2
Totals	54·19	111	60·63	119	42·94	93

ANNUAL BULLETIN REPORT, MAIGANA SEED FARM, 1929.

Mr. A. H. S. Vigo, West Indian Overseer, was in charge of the farm throughout the year.

The rainfall recorded, 46·20", is somewhat higher than the average rainfall recorded over twenty-two years in Zaria; the month of April was, however, the driest for a number of years only 19" being recorded. This factor not only hindered preparation of the land, but materially affected the sowing of earlier crops. Further, the months of August and September turned out to be very wet and cloudy. Fortunately, however, showers of a light nature continued well into October—a few falling in early November—and the harmattan was hardly noticeable until all crops had practically matured.

Cotton. (See Table No. 2).

The year's work was confined mainly to the multiplication, of Strain "D" seed supplied by the Botanist at Samaru. Strain "D" cotton was multiplied here for the first time in 1928, and the resultant seed sent to the Empire Cotton Growing Corporation's Seed Farm in 1929, where it was multiplied over some 400 odd acres. The strain multiplied here this season represents the progenies of sister plants of the original Strain "D" but of a later year. The weight of seed supplied by the Botanist for multiplication was 120 lb., and by using "Balls" sand sowing process, whereby a dibbled hole is supplied with a single seed and afterwards filled to the brim with prepared sand, it was possible to sow an area of fifty acres. After the main sowing and several supplyings had been completed, the seed rate worked out at 2·4 lb. per acre. The first sowing produced an average stand, of 50·5 *per cent.* Subsequent sowings, *i.e.*, supplyings, however, gave an additional 29·5 *per cent.* bringing the total average stand to eighty *per cent.* The stand was, however subsequently reduced to seventy-one *per cent.* by "Damping off" disease (*Sclerotium Bataticola*).

The yield was adversely affected by wet conditions during August and September; cultivation being practically impossible at a time when the crop needed it most, and although the stand finally obtained was better than that of last season, yet the average return of seed cotton over the entire area of fifty acres was only 286 lb. per acre or nearly seventeen *per cent.* less than last season's. This drop in yield was not only confined to this farm, but to native farms in the district as well. At Samaru the same strain of cotton

gave some thirty *per cent.* less yield per acre, owing to causes mentioned above. The total yield from the whole area was of 14,299 lb. of seed cotton of which 99·36 *per cent.* was Grade I and only 64 *per cent.* *i.e.* ninety-two lb. was Grade II.

The seed return per acre obtained was 182·2 lb. and represents a yield of 80 lb. of seed for every one sown.

The whole crop was ginned on the Farm on two "Asa Lees" hand saw gins. The average lint percentage, 30·86, is a little below that of last season which was 31·64 *per cent.*; and it is noticeable that on Blocks "C" and "H" where slight waterlogging was prevalent a drop in lint percentage has occurred and the lint rendered somewhat weak.

Seed Distribution Strain "D".

The first lot of seed (110 lb.) released by the Botanist at Samaru and put through the first stage of multiplication here in 1928, produced 9,200 lb. of seed. Of this 2,500 lb. were sent to Daudawa, 1,200 lb. grown as a belt around this station, and the balance sent to other stations of the Department. This season 9,600 lb. of seed have been obtained from 120 lb. supplied by the Botanist and is available for the Empire Cotton Growing Corporation's Seed Farm. Five tons of seed are also available from the belt sown around the farm for distribution in the District.

Guinea-corn and Millet (See Table No. 3).

Millet was sown in the furrows with the first rains, and guinea-corn on the ridges a few weeks after the former was well above the ground. The treatment given was the same as last season *i.e.*, growing mucuna as a straight crop, harvesting the seed, and folding the haulms by kraaling cattle over the land at the rate of 300 per acre. In spite of wet conditions which greatly reduced the yields of most crops, a return of 1,607 lb. of cleaned guinea-corn and 451 lb. of millet—a total of 2,058 lb. of grain in all, was obtained from a single acre. The value of the above treatment is becoming more marked each season owing to its cumulative effect year after year.

Green Manuring Crop, Mucuna.

Fifteen acres of mucuna were grown as green manure to be followed by cotton next season. The seed was sown in May and after becoming established received no further attention until September when it was cut and turned into the soil. The weight of green dressing turned in was calculated at 5½ tons per acre.

Seed Crop, Mucuna.

Ten acres grown for seed, owing to waterlogging of the Block, failed to produce more than 140 lb. of clean seed per acre.

Miscellaneous Crops.

Crops of minor importance, viz. sugar canes, West Indian Tannias and Eddoes, Guinea grass and Elephant grass were maintained on small plots for supplying other stations. Kworre station at Sokoto was supplied with 1,500 sugar cane sets, while several thousand plants of both grasses mentioned above were supplied to Samaru.

TABLE No. 1.

RAINFALL RECORD—MAIGANA.

Month.	Inches of rain recorded 1929.	No. of days on which rain fell.	Rainfall 1928.	No. of days.	REMARKS.
January... ..	...	...	...	...	
February... ..	...	...	...	...	
March... ..	...	...	...	...	
April... ..	19	3	1.83	6	
May... ..	4.85	10	8.84	14	
June... ..	5.41	11	3.75	10	
July... ..	9.58	13	8.12	18	
August... ..	13.15	20	9.84	15	* Wet and cloudy throughout.
September... ..	9.19	19	6.59	12	
October... ..	3.00	8	3.13	6	
November... ..	.83	1	...	...	
December... ..	...	...	...	...	
Total... ..	46.20"	85	42.10"	81	

Increase in 1929 Rainfall over 1928 = 4.10"

" " 1929 Rain Days over 1928 = 4 days.

TABLE No. 2.
YIELDS OF COTTON—STRAIN "D" (ALLEN)

Block.	Variety.	Acreage.	Treatment.	Yield per acre in lb. Seed Cotton.	Ginning % Lint.	REMARKS.
A	Allen Strain 'D'	10	300 C.N. per acre Kraaling	255.0	31.78	Slightly water- logged during rains.
C	do.	10	Green Manure— Mucuna—whole year 1928	262.9	30.77	
F	do.	10	do.	217.9	31.22	
G	do.	10	1,000 C.N. per acre Kraaling	415.2	31.11	do.
H	do.	5	Green Manure— Mucuna — for whole year 1928	276.4	29.84	
K	do.	5	300 C.N. per acre Kraaling	282.2	30.45	

- (1) Cost of Cultivation in M.D.P.A. 80.
- (2) Dates of planting 6-12/7/29.
- (3) Dates of harvesting 2/1/30 to 25/2/30.
- (4) Average yield seed cotton per acre 286 lb.
- (5) Average lint percentage 30.86.

TABLE No. 3.
GUINEA-CORN AND MILLET.

Block.	Plot.	Variety.	Acreage.	Treatment.	Yield per acre Threshed Grain in lb.	REMARKS.
D		Millet (Bulrush) (Selected)	10	Mucuna folded and Kraaling at 300 C.N. per acre	451	Interplanted.
D	D 1	Kaura (Selected)	5	do.	940.5	
	D 2	Faragara (Selected)	5	do.	666.4	

- (1) Cost of cultivation of millet in M.D. per acre 23.86
- (2) " " " " Guinea-corn do. 42.3
- (3) Date of planting millet 8th to 9th April, 1929—Guinea-corn 18th to 19th May, 1929.
Date of harvesting millet 8/24/7/29 Guinea-corn 27-11-29 to 10-12-29,

TABLE No. 4.

COST OF CULTIVATION OF CROPS FOR SEASON 1929/30
IN MAN-DAYS PER ACRE.

Crop.	Acreage.	Preparation.	Manuring (a) Kraaling. (b) Green Manure.	Planting.	Guarding.	Cultivation.	Harvesting.	Ginning.	Total.
Cotton ...	50	12·15	(a) 13	*9·48	·12	25·92	9·9	9·58	79·84
Guinea-corn	10	6·43	(a) 2	5·70	...	20·90	7·30	...	42·33
Millet (Interplanted)	10	11·06	(a) 2	2·50	...	3·90	4·40	...	23·86
Mucuna (Seed Crop)...	10	14·23	...	3·70	...	18·23	†11·06	...	47·22
Mucuna (Green Manure)	15	1·62	...	4·00	...	(c)22·42	...	...	28·04

* Balls Sand Sowing Method employed—includes cost of sand.

† Includes cost of threshing seed.

(c) Includes cost of digging in Mucuna and Ridging land.